TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1898

VOL. XXXI.

(Fourteenth of New Series)

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BY

SIR JAMES HECTOR, K.C.M.G., M.D., F.R.S.

Director

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CORRIGENDA IN VOL. XXX., ART. LIV.

Mr. J. A. Erskine, M.A. and Ex. 1851 Sc. Scholar., has sent from London the following corrections to his paper:—

Page 462—

Equation, line 3. *For* L_2 *read* i_2.

" line 7. *For* L_8 *read* i_8.

" line 11. *For* $\frac{dt_2}{dt}, \frac{dt_1}{dt}, \frac{dt_8}{dt}$ *read* $\frac{di_2}{dt}, \frac{di_1}{dt}, \frac{di_8}{dt}$.

" line 11. *For* $R_2 L_2$ *read* $R_2 i_2$.

" line 13 (on left side). *For* L_2 *read* i_2.

Line 15. *For* L_2 read i_2.

[After title

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

Board of Governors.

(EX OFFICIO.)

His Excellency the Governor.
The Hon. the Colonial Secretary.

(NOMINATED.)

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(ELECTED.)

1898.—James McKerrow, F.R.A.S., S. Percy Smith, F.R.G.S.; Hon. C. C. Bowen.

Manager: Sir James Hector.

Honorary Treasurer: W. T. L. Travers, F.L.S.

Secretary: R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

Gazetted in the "New Zealand Gazette," 9th March, 1868.

Section I.

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty-five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one-third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and library of the New Zealand Institute.

4. Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

Regulations regarding Publications.

(*a*.) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions, comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b*.) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c*.) Papers so rejected will be returned to the society in which they were read.

(*d*.) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e*.) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f*.) Extra copies will be issued to any of the members of incorporated societies at the cost-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

SECTION II.

For the Management of the Property of the Institute.

9. All donations by societies, public departments, or private individuals to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions:—

(*a.*) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b.*) Any funds especially expended on binding and preserving such deposited books at the request of the depositor shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c.*) No books deposited in the library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and library, subject to by-laws to be framed by the Board.

SECTION III.

The laboratory shall for the time being be and remain under the exclusive management of the Manager of the Institute.

SECTION IV.

(OF DATE 23RD SEPTEMBER, 1870.)

Honorary Members.

Whereas the rules of the societies incorporated under the New Zealand Institute Act provide for the election of honorary members of such societies, but inasmuch as such honorary members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of honorary members of the New Zealand Institute, it is hereby declared,—

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.

2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next-succeeding meeting.

3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

ROLL OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd Oct., 1868.
Otago Institute	18th Oct., 1869.
Westland Institute	21st Dec., 1874.
Hawke's Bay Philosophical Institute	31st Mar., 1875.
Southland Institute	21st July., 1880.
Nelson Philosophical Society	20th Dec., 1883.

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1899.—*President*—E. Tregear, F.R G.S.; *Vice-presidents*—G. V. Hudson, F.E.S.; Sir J. Hector, F.R.S.; *Council*—R. L. Mestayer, M. Inst. C.E.; H. B. Kirk, M.A.; G. Denton; M. Chapman; E. F. Hawthorne; Sir W. Buller, F.R.S.; B. M. Molineaux; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1899.—*President*—J. Batger; *Vice-presidents*—H. A. Talbot-Tubbs, E. Roberton, M.D.; *Council*—G. Aickin, W. Berry, C. Cooper, F. G. Ewington, E. A. Mackechnie, P. Marshall, F.G.S., T. L. Murray, T. Peacock, D. Petrie, F.L.S., J. A. Pond, F.C.S., J. Stewart, C.E.; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute shall be proposed in writing by two members, and shall be balloted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance-fee, in addition to the annual subscription of one guinea, the annual subscription being payable in advance on the first day of April for the then current year.

5. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OFFICE-BEARERS FOR 1899.—*President* — L. Cockayne; *Vice-presidents*—R. Speight, Dr. W. H. Symes; *Hon. Secretary*—Professor A. Dendy; *Hon. Treasurer*—Captain F. W. Hutton; *Council*—Dr. Evans, H. R. Webb, R. M. Laing, T. W. Naylor Beckett, J. B. Mayne, and Professor Arnold Wall; *Hon. Auditor*—R. C. Bishop.

Extracts from the Rules of the Philosophical Institute of Canterbury.

8. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the 1st November in each year.

The Institute may also admit associates, who shall contribute five shillings annually to the funds of the Institute, and shall have all the privileges of members, except that they shall not have the power to vote, or be entitled to the annual volume of the Transactions.

9. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

15. The ordinary meetings of the Institute shall be held on the first Wednesday in each month during the months of May to October, both inclusive.

OTAGO INSTITUTE.

OFFICE-BEARERS FOR 1899.—*President*—F. R. Chapman; *Vice-presidents*—Dr. Scott, A. Bathgate; *Council*—Professor Benham, Dr. Hocken, Dr. Shand, G. M. Thomson, B. C. Aston, E. Melland, Crosbie Smith; *Hon. Secretary* — A. Hamilton; *Hon. Treasurer*—J. S. Tennant; *Auditor*—D. Brent.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the society may be elected by ballot, on being proposed in writing at any meeting of the Council or society by two members, and on the payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An annual general meeting of the members of the society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

WESTLAND INSTITUTE.

Office-bearers for 1899.—*President*—T. H. Gill; *Vice-president* — G. K. Sinclair; *Hon. Treasurer* — A. Mahan; *Trustees* — Messrs. Morton, Clarke, King, Dawes, Beare, Michel, Falla, Perry, Macfarlane, McNaughton, and Drs. Macandrew and Teichelman.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist (1) of life members—*i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards, or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the committee or at the general half-yearly meeting; (2) of members who pay two pounds two shillings each year; (3) of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Office-bearers for 1899.—*President*—T. Tanner; *Vice-president*—J. E. H. Jarvis, M.R.C.S.; *Council* — R. D. D. McLean, M.H.R., J. Caughley, H. Hill, B.A., F.G.S., A. Milne-Thomson, M.B., C.M., D. Dinwiddie, T. C. Moore, M.D.; *Hon. Secretary*—J. Hislop; *Hon. Treasurer*—J. W. Craig; *Hon. Auditor* — J. R. Crerar; *Hon. Curator* — A. Norris, F.E.S.

Extracts from the Rules of the Hawke's Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

SOUTHLAND INSTITUTE.

OFFICE-BEARERS. — *Trustees* — Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

OFFICE-BEARERS FOR 1899.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. Mackie; *Council*—Dr. Boor, Rev. F. W. Chatterton, Messrs. Gibbs, Lukins, and Bartell; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. Hudson; *Hon. Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins.

Extracts from the Rules of the Nelson Philosophical Society.

4. Members shall be elected by ballot.

6. The annual subscription shall be one guinea.

7. The sum of ten guineas may be paid in composition of the annual subscription.

16. Meetings shall be held on the second Monday in every month.

23. The papers read before the Society shall be immediately delivered to the Secretary.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE, 1898.

I.—ZOOLOGY.

Art. I.—*On the Ornithology of New Zealand.*

By Sir Walter L. Buller, K.C.M.G., D.Sc., F.R.S.

[*Read before the Wellington Philosophical Society, 22nd November, 1898.*]

Plate I.

Undoubtedly the most important ornithological event of the year in New Zealand has been the capture of another specimen—only the fourth during more than half a century—of the Takahe (*Notornis hochstetteri*). On hearing that this valuable bird had been sent in the flesh to the Otago Museum, I telegraphed to that institution for further information, and immediately received the following reply from Professor Benham: "Every particle of *Notornis* preserved; young female in perfect condition, but coracoids injured." A few days later I received a letter from Mr. George Fenwick, the editor of the *Otago Daily Times*, containing further particulars. He says:—

"I have been very much interested in the recent capture of a Takahe by young Ross—brother of the Te Anau–Milford guide—and had an opportunity this morning of inspecting it. It is a fine specimen, and realises the impression of the bird gathered from the striking illustration in your book. The two specimens in the South Kensington Museum are disappointing—one of them particularly so. The better one of the two cannot compare with the specimen just captured, the plumage

of the latter being bright and glossy, whereas that in the South Kensington Museum is dull. Jennings has done his work well, the new Takahe presenting the firm, well-set-up, striking look with which we have been made familiar by your illustration. I hope it may be secured for the colony. I have written to Ross on this point, and if I make any progress will let you know. I am posting you a copy of to-day's *Times*, with some notes on the bird and the species by Professor Benham."

The article referred to—in the issue of the 23rd August—gives an interesting, popular account of *Notornis* and its discovery, from which I quote the following:—

"In size the bird is like a goose, but in colouration it resembles the Pukeko; its breast is a beautiful rich dark-blue, becoming duller on the neck, head, abdomen, and legs. These last are clothed with feathers for a greater distance than in the native turkey, but they are relatively shorter and much thicker than in the latter bird. The legs in both birds have the scaly part, technically termed 'tarso-metatarsus,' as well as the toes, coloured salmon-red. The feathers of the back, wings, and tail are olive-green, with an almost metallic lustre in certain lights; below the short tail the feathers are pure white. When the bird is seen from in front these colours are at their brightest and best; seen from behind—as when the bird is running away from the hunter—the brightness is lost: the blue becomes dull and nearly black, the green becomes greenish-grey, so that if it were not for the white tail the bird, when retreating, would be very inconspicuous in the feeble light of the bush. This white tail-piece occurs in the Pukeko, as well as in some mammals, such as the rabbit and deer, but its meaning is not always obvious; although the general inconspicuousness to foes is diminished, yet its recognition by friends appears to be attained thereby. The eyes are red-brown. But perhaps one of the most noticeable features of the bird is its beak—a great equilateral triangle of hard pink horn, with one angle directed forwards. At the upper side of the base of the beak is a bright-red band of soft tissue like an attempt at a 'comb,' such as we get in cocks, only transversely placed. The whole is a handsome bird of heavy gait, absolutely unable to use its wings for their natural purpose of flying. Indeed, one of the interests, zoologically, is that, like several of our native birds, it is flightless, while its congeners in other countries are endued with powers of flight. The Takahe is closely allied to the Pukeko (*Porphyrio*), and not far removed from the Brown Woodhen (*Ocydromus*), all these belonging to the family of Rails, which usually frequent more or less marshy ground, and in other countries are able to fly as well as other birds. On the other

hand, the Takahe can run very actively, and gave a good chase to those who captured the earlier specimens, while its powerful beak must be a formidable weapon, one would think, which it could use with effect on enemies when at close quarters. The nature of its food is practically unknown. The previous specimens did not reach scientific hands till after the removal of the viscera; the present specimen, however, reached me in such excellent condition that I have been able to examine all the internal organs, and I find the stomach and intestines filled with a kind of grass with cylindrical leaves, all cut up into lengths of $\frac{1}{4}$ in. to $\frac{1}{3}$ in. But whether this is its normal food or not is uncertain. Like its predecessors, it was caught in winter on low-lying grounds near the water; but there is no doubt but that it lives usually in the higher and rougher bush, and it was probably driven down to the water's edge by stress of weather and the consequent difficulty of getting enough to eat. Certain it is that, though thoroughly healthy in every way, there was no fat in the body such as one finds in a normally well-fed bird; moreover, its beak seems needlessly powerful for cutting up grass.

"The present specimen is a young female, possibly not quite fully grown. The measurements of the various external parts of the body agree almost exactly with those given by Sir W. Buller for the bird examined by him nearly twenty years ago. Yes; it is nineteen years since the previous specimen was captured, and—*pace* Mr. Park—it is uncertain whether any have even been seen since 1879; at any rate, I believe there is no record of such a fact. Even a greater length of time separates the capture of the third from the first specimen—to wit, thirty years—for it was in 1849 that the first specimen ever seen by scientific folk was chased and captured by a party of sealers in Duck Cove, Dusky Sound. Of this the skin alone remains, stuffed and set up in the British Museum; the rest of the bird was eaten by the captors. The second specimen, which was caught in 1851 by Maoris on Secretary Island, Thompson's Sound, also found its way to the British Museum. The third specimen was caught by a rabbiter's dog (1879) on the eastern shore of Lake Te Anau, and its remains were purchased for the Dresden Museum for one hundred guineas. The three spots at which the captures were made are at the corners of a triangle, each side of which measures about a hundred miles. It is scarcely surprising, then, that this, the fourth specimen of the bird, now temporarily deposited in the Otago University Museum, should be the cause of some excitement amongst all those—and these are happily many—who take an interest in the birds of New Zealand, especially in those which, like the Takahe and the Kakapo, are on the way to extermination—a result of the interference

with the 'equilibrium of nature' brought about by the ferrets so thoughtlessly introduced by a too impulsive Government some years ago.

"The specimen now in the Museum belongs to Mr. Ross, brother of the guide of that name. It appears that Ross was walking along the shore of Lake Te Anau, accompanied by his dog, which suddenly disappeared into the bush, and reappeared carrying the Takahe. Mr. Ross, fortunately for science, despatched the bird to Dr. Young, of Invercargill, who wired to me to inquire whether I could recommend a taxidermist who could be trusted to preserve the bird with all the tender care merited by its rarity and interest. The Museum luckily possesses, in the person of Mr. E. Jennings, not only a skilful taxidermist, but an ornithologist who can value a bird for its own sake. So I replied to Dr. Young to send it along; and I announced the receipt of his telegram to the meeting of the Otago Institute on the 9th August, where the news was received with very great interest. Mr. Hamilton took the trouble to travel to Invercargill next day in order to bring back the bird, and to learn the facts of the capture; but in the meantime it had been despatched to Dunedin, and reached me in capital condition. It was at once handed over to Mr. Jennings. The skin was properly and skilfully cured, so much of the skeleton as was possible was removed and dried, and the viscera are preserved in spirit. Mr. Jennings, it may be mentioned, preserved the Dresden skin, so far as it was possible to do so after its unskilful treatment by the captor. . . .

"But, although the skin of the Takahe is very rare, its bones are less rare and less expensive. The Otago Museum is fortunate enough to possess a nearly complete skeleton, including the only skull on public exhibition in the colony, or anywhere else indeed, except London and Dresden. Other bones exist in private collections, but they are by no means numerous. Another feature of interest lies in the fact that the Takahe (*Notornis*) exists nowhere else in the world except in the South Island of New Zealand. The name *Notornis mantelli* was bestowed by the late naturalist, Sir Richard Owen, on a few bones discovered in a fossilised condition in the North Island—viz., a part of a skull, a jaw, and a leg-bone. The examination of the skeleton of the second bird, subsequently captured in the South Island, led ornithologists to conclude that both the living and the extinct bird belong to the same species. But later on careful measurements of the bones in the Dresden Museum by Dr. A. B. Meyer, and of the bones in the Otago Museum by the late Professor Parker, as well as of bones obtained by Mr. Hamilton, render this identity very doubtful. Dr. Meyer has, as a result of his

measurements, given the name *Notornis hochstetteri* to the living bird, and we shall probably be right in accepting this revision of the name. It may be that the fossil bones, imperfect as they were, belonged to a male bird, whilst the remaining specimens are females, but this is extremely improbable. At present we do not know for certain whether there is any difference in the colouration or in the size of the two sexes; one in the British Museum, according to Sir W. Buller, is more brightly coloured than the Dresden specimen, which he believes to be a female. But no anatomical examination of any of the previously obtained birds was possible for the purpose of deciding the sex, and the only definite fact is that this fourth specimen is a female, and that it agrees in size and colouration with the Dresden specimen. From analogy with our other native birds it is quite probable that a different species of *Notornis* inhabited each of the two Islands — that of the North Island is extinct, that of the South Island will become so shortly."

As an indication of the interest which this fresh capture of *Notornis* has excited, I may mention that numerous offers have been made to the owner for its purchase, for various sums up to £300. I understand that the Government is now negotiating for it, at a lower figure; but whether successful or not we must all join in the hope expressed by Mr. Fenwick that it will be kept in the colony, either in one of our public museums or in some private collection where it will always be accessible to those of our rising colonists who take an interest in the natural history of New Zealand. Mr. Hamilton, the Registrar of the Otago University, has kindly forwarded me an excellent photograph of the bird, as mounted, which I have much pleasure in exhibiting this evening. (See Plate I.)

This reference to the rare *Notornis* naturally leads me to say a few words about our other vanishing forms of bird-life. And here, parenthetically, I may observe that perhaps I owe some sort of apology to the Society for so often dilating on this subject. But to me it is one of absorbing interest, and I have always in my mind Professor Newton's prophetic words. In the "Encyclopedia Britannica" (p. 742) he says: "As a whole, the avifauna of New Zealand must be regarded as one of the most interesting and instructive in the world, and the inevitable doom which is awaiting its surviving members cannot but excite a lively interest in the minds of all ornithologists." In another place he urges "the importance of the closest study, because the avifauna is now being fast obliterated by colonisation and other agencies, and with it will pass into oblivion, unless faithfully recorded by the present generation, a page of the world's history full of scientific interest." In his last publication, the "Dictionary of Birds"—a book

which should be on the shelf of every ornithologist—he returns to the subject (p. 316) with the following pregnant remarks: "Mention has already been made of the unhappy fate which awaits the surviving members of the New Zealand fauna, and its inevitable end cannot but excite a lively regret in the minds of all ornithologists who care to know how things have grown. This regret is quite apart from all questions of sentiment; but, just as we lament our ignorance of the species which, in various lands, have been extirpated by our predecessors, so our posterity will want to know much more of the present avifauna of New Zealand than we can possibly record, for no one can pretend to predict the scope of investigation which will be required, and required in vain, by naturalists in that future when New Zealand may be one of the great nations of the earth."

For my own part, I am most anxious that we should escape the reproach of posterity by doing everything in our power to preserve, if not a few living representatives, at any rate a full life-history of these expiring forms; so I try to make my voice heard, in season and out of season, hoping thereby to stimulate others to do the same. I am induced to believe that, in the interests of science, I am pursuing the right course. For example, a returned colonist writes me: "At Cambridge I met the genial old Professor Newton, who told me that your sketches of vanishing native birds were the most charming he had ever read." I naturally argue thus: that, if the subject possesses so much attraction for readers at a distance, I shall not weary you by reverting, on every opportunity, to this favourite theme. The great thing is to awaken public interest. And, if I may venture to say so, the subject is yours as much as mine, for it must be borne in mind that an implied duty rests on all the members of such a Society as this to contribute their quota to the general stock of human knowledge, and to aid—each one according to his opportunity and ability—in the promotion of such objects as the one I am discussing. It is refreshing to find, in these more enlightened days, that even from the pulpit this moral obligation is enforced, and with no uncertain voice. As an illustration of this, I may remind you of the eloquent sermon preached by the Bishop of Salisbury in St. Paul's Cathedral on the occasion of his visit to Wellington some time ago. Passing out of the beaten track, his Lordship referred to the interesting problems in science that awaited their solution in New Zealand, mentioning specially the abnormal features in the fauna and flora. He said he hoped that in the City of Wellington—the centre of activity for the colony—there would be found men of leisure who would "consecrate their lives" to the elucidation of those problems in natural science. He put in, too, a pathetic appeal

for the beautiful virgin forest, and expressed an earnest hope that the hand of the destroyer would spare some portions of this magnificent bush, with its unique forms, and pass them down for the delight and study of future generations.

The beautiful Huia, famous alike in Maori tradition and song, is becoming every year more scarce, notwithstanding its close protection by a statute which, I am glad to say, is very rigidly enforced by the police in the bush districts. This is, no doubt, owing mainly to the inevitable destruction of its favourite forest haunts in the steady march of European settlement, large areas of bush land being annually cleared and burnt off in the Forty-mile Bush as elsewhere. Apart from this, the periodical recurrence of devastating bush-fires, originating nobody knows how, is altering the whole aspect of the country. However much this may be deplored, it is one of the necessary accompaniments of colonisation in a country like this. Owing to such causes, the range of the Huia, always very limited in extent, is becoming more and more restricted every year, and its ultimate fate is not a matter of mere speculation. I was never more impressed with this than when I made an ascent of the Ruahine Range in July last. A widespread conflagration had swept through and killed many thousands of acres of virgin forest on the side of the range towards Woodville; but, on getting beyond and above this scene of desolation, we found the mountain-side clad with thick vegetation. This consists on the lower ranges of the usual mixture of native trees, but at a higher elevation it changes almost entirely to tawhero, or mountain-cedar, which becomes more and more stunted the further you ascend, till at length it is as gnarled and twisted in its growth as the olives of Gethsemane, to which, indeed, the trees in this condition present a remarkable likeness. At an altitude of 1,800 ft. the lovely *Todea superba* made its first appearance, but this fern soon became the dominant plant, and we at length found ourselves in patches of it many acres in extent, looking very beautiful in its symmetrical fronds of vivid green. We reached the summit of Whariti (3,500 ft.) in good time, and then stood on the dividing-line between the Provincial Districts of Wellington and Hawke's Bay. The sky being clear, we had a magnificent panoramic view of the surrounding country, both east and west coasts being visible, and the cone of Mount Egmont in the far north, whilst a distant veil of cloud alone prevented our seeing Ruapehu and the burning mountain. We descended by the same route, crossing several densely wooded spurs, and arriving at the foot of the range before nightfall.

Although the season was favourable, and the weather perfect, there was an almost total absence of bird-life. During

the whole excursion we never saw or even heard the note of the Tui; we shot a Kaka, heard a Parrakeet, and saw a single Huia (a fine female bird), which, on our near approach, went bounding through the mountain vegetation with the swiftness of a greyhound. Formerly this was a favourite haunt of this elegant mountain starling, which could always be attracted by an imitation of its peculiar whistling cry; now it has all but vanished. Seeing that excellent insular preserves have been acquired by the Government, it seems to me a great pity that an effort is not made, before it is too late, to capture a few live Huias and turn them out on the Little Barrier, on Kapiti, and on Resolution Island. Unless this be done, the final extinction of this species can only be a matter of a few years. Its powers of flight are so limited—its progression being generally effected by a bounding movement through the branches—that, once safely introduced, there would be no danger of its quitting its island home for the mainland; and the difference of climate at the three points I have indicated would give the experiment every chance of success. The cost would be very small, as this bird is easily snared; and, if the Government would not defray the trifling expenditure necessary, the task might be properly undertaken by our Acclimatisation Society. From a zoological point of view, it is even of more importance to preserve the Huia for the student of the future than the little Stitch-bird, about which so much has of late been said and written. The Huia is more tamable than perhaps any other New Zealand bird, and will accept suitable food almost immediately after being caught; so there would be no practical difficulty in effecting its transportation to any part of the colony. It should be remembered, also, that this was part of the original scheme proposed by Lord Onslow, whose celebrated memorandum to his Ministers gave the first impulse to this island-conservation which has so taken hold of the popular fancy.

During a recent discussion in the House of Representatives as to the propriety of protecting the Woodhen in the South Island it was stated by a Minister of the Crown that he possessed authentic information that this bird was increasing on the Canterbury Plains, and might therefore be left to take care of itself. As to certain favourable localities, this statement is no doubt quite true; but to those who remember how abundant the Woodhen was on the plains in the early "sixties" it will seem now that the bird is practically a thing of the past. I recollect when travelling on horseback towards Waimate South in 1859, accompanied by a single Maori, we were overtaken by darkness, and had to camp in the open, using our saddles as pillows. It was a fine night, although somewhat dark, and my companion's little dog spent the

night in catching Woodhens. The ground was pretty thickly covered with stunted *Coriaria*, and the birds were, no doubt, feeding on the berries of that plant; at any rate, the dog had no difficulty in running them down. The speedy and very general destruction of the Woodhens on the Canterbury Plains was occasioned chiefly, I think, by the tussock-fires which about that period, and later on, were so universal for the purpose of improving the grazing capabilities of the newly occupied sheep-runs. That this bird will increase rapidly enough when under careful protection is beyond doubt. I remember seeing at Government House, in Wellington, about the year 1863, a cage of them which Sir George Grey had brought from the South Island, and was taking up to his island in the Hauraki Gulf. When, many years later, I visited the "great proconsul" at Kawau he told me that the Woodhens had so increased and multiplied that he was practically unable to keep any other ground-birds on the island. The Maori member, Mr. Parata, urged as a reason for preserving the Woodhen that the oil produced from its fat was useful medicinally. To the zoologist other more cogent reasons will suggest themselves. As every student knows, as a flightless bird it is one of the most interesting of our endemic forms; however, I will not enlarge upon that subject now. To show how completely the Woodhen has disappeared from some districts, I may mention that Mr. Morgan Carkeek, during several months' surveying last year in the mountainous district of Marlborough, met with only a single example. This, in a district where a few years ago it was extremely abundant, is very significant.

The same remarks apply, in a modified degree, to *Ocydromus greyi* in the North Island. In certain restricted localities it appears to be increasing. A few years ago it had quite disappeared from the Ohau district, and its pleasing cry—so like the plaintive call of the European Curlew—was a thing of the past. But during the last two seasons it has reappeared at Papaitonga, breeding in a wooded gully near the homestead, and on the approach of evening announcing its presence by its shrill cry. On any quiet evening now at the lake you may hear the Weka's cry, in which both sexes join, and mingling with it the call of the Pukeko in the sedges, the loud boom of the Bittern in the swamp below, and the pleasant chattering of numberless Wild-duck and Teal, of which there are sometimes five hundred or more on the bosom of the lake.*

* On this subject I have received the following very interesting letter from the Hon. L. Walker, M.L.C. (of "Four Peaks," Geraldine): "I read with much pleasure the signed article contributed by you to the *Press* as to the disappearance of certain of the New Zealand birds. Among these

The only species of Woodhen that remains with us in undiminished numbers is *Ocydromus earli*, an inhabitant of the wooded country on the west coast of the South Island.

As I have remarked before, the advantage to our native birds of compulsory protection has been amply demonstrated by results. Take, for example, the Tui. In the early days of settlement this was the commonest of our birds, whilst certainly not the least interesting. But some twenty years ago it was becoming so scarce in all the settled districts that lovers of birds became alarmed, and in the end the strong arm of the law had to be invoked for its protection. As a consequence, this species is now as plentiful as ever; indeed, in some places, it is visibly increasing. It would, of course, be absurd to expect birds whose subsistence depends on bush products to survive in districts where there is a wholesale destruction of the forest. In the miserable little fringes of native bush that are allowed to remain in such districts the indigenous birds, as might have been expected, are silenced for ever, and, instead of the sweet notes of the Tui, one hears the twitter of the Sparrow or the call of the Californian Quail. But the case is wholly different where ample bush reserves have been made. I consider it one of the principal charms of my country home at Papaitonga that the Tui is most plentiful there, enjoying the freedom of its native woods unmolested, and nesting freely wherever the local conditions are favourable. To add to the inducements to stay, I have planted the edges of the native bush with Australian *Acacia*, *Eucalyptus*, and bottle-brush, the flowers of which trees are a "perpetual joy" to the Tui.

Those who have observed this bird at all closely will be aware that it is in the nesting season—from September to

you mention the Woodhen. All about my place I have a lot of scrub and (sub-alpine) bush, and the number of Woodhens that I used to have was something wonderful. I think it was somewhere about five years ago that they suddenly disappeared, and for three or four years their note was never heard in the evenings, nor at any other times. The bush was still there for them, for I never allow a stick to be cut out of it. However, last year I began occasionally, but rarely, to hear them tuning up in the evenings, and this year there are hundreds of them. But they seem to stick about the gardens and under the Lawsonias, cedars, &c., rather than go into the bush. This, I fancy, they do so as to be handy to the hens' nests, for my women say they take most of the eggs. I used to have thousands of Tuis, Bell-birds, and Pigeons: the last, of course, are clean gone. But I have still a good lot of the other two, although they come and go at different seasons. Just opposite my house I have got a lot of kowhai-trees, which in the beginning of October are a mass of yellow blossom. Then comes the holiday time for the Tuis, Bell-birds, and Kakas. They are there in hundreds; but most of them go away as soon as the blossom is over, which, as you know, is but a short time. However, there is never a sunshiny day in winter that I have not a few native birds singing in my garden."

December—that the Tui poses as a songster, and shows off to the greatest perfection. Whilst the hen-bird is sitting the male is accustomed to perch himself on the high limb of a tree not far distant from his mate, using this as a post of outlook; and then, throughout the whole day, he pours out his soul in song. Puffing out his body-feathers and gesticulating freely, so as to give greater emphasis to his song, he produces quite a medley of musical notes, interspersed at intervals with that peculiar cough, and a sound not unlike the breaking of a pane of glass, followed by a series of gentle sobs. Then, quick as thought, he dashes upwards and makes a wide circuit in the air, or silently dives into the bush to exchange courtesies with his mate, snaps at a fly on the way, and then returns to his post of observation and song. After sunset, and as the shadows of evening begin to darken the forest, he alters his song, and utters a succession of notes like the tolling of a distant bell. Many of the passages in the Tui's ordinary song are of surpassing sweetness, and so rapid is the change from one set of notes to another that one never tires of listening to the wild melody. Both sexes sing, but in the breeding season the female confines her efforts to a produced note like the low chirping of a turkey-hen. As already mentioned, the male has an evening song quite distinct from that of the bright morning. To many ears it has a resemblance to the tolling of a highly pitched silver bell, but to me it is more suggestive of the distant tapping on a metal anvil. Of course, these resemblances are merely fanciful, but the musical cadence of the note is exquisite, as all who are familiar with it will readily admit.*

In one of my former papers I referred to the beautiful collection of New Zealand rarities, as well as birds from all other parts of the world, brought together by the Rev. Canon Tristram, F.R.S., at Durham, and I expressed the hope that so valuable a collection might ultimately find a resting-place in some public museum. I am glad to say that this hope has been realised, and that it is now safely lodged in the Liverpool Museum, under the charge of Dr. H. O. Forbes, formerly Curator of the Canterbury Museum, who, at any rate, can fully estimate the value of New Zealand rarities. And I may here mention an interesting piece of information conveyed in Canon Tristram's last letter. He says, "I do not know if you have heard of the 'find' at Liverpool. Forbes came across two cases in some corner of the Museum. They had been received from the then Lord Derby, probably soon after 1845.

* On a quiet summer evening the Tui may sometimes be heard long after dusk. On the wooded shores of the Papaitonga Lake I have heard them tolling up to 9 o'clock at night, the notes having a very sweet effect on the water.

At any rate, they were a collection of New Zealand birds made about 1845 by a Captain Stanley, R.N. Though bedded in the dust of fifty years, neither damp nor moth had reached them, and they are all good sound skins in perfect order. There are some half-dozen *Sceloglaux albifacies*, plenty of Morepork, the three *Falconidæ*, no *Nestor notabilis*, no Quail, no *Turnagra hectori*, plenty of the other *Turnagra*, several Stitch-birds (male and female), both Miros, several Saddle-backs, but only one species of *Glaucopis*, *Orthonyx albicilla*, *O. ochrocephala*, *Certhiparus*, plenty of Wekas, Black Stilt, no *Thinornis* or *Anarhynchus*. He had evidently not visited the Chathams. But the collection shows how plentiful many of the perishing or perished species were fifty years ago. Did I tell you I saw living, in good health, in a conservatory in Norfolk, a specimen of *Sceloglaux*, brought Home by a son of Sir Thomas Fellows, at whose place I saw it?"

Glaucopis wilsoni, Bonap. (Blue-wattled Crow.)

A perfect albino of this species, obtained in the Wairarapa Valley, has the whole of the plumage pure white, with a tinge of cream-colour on the under-parts of the body; bill and feet horn-coloured; wattles flesh-colour.

Creadion carunculatus, Gmelin. (The Saddle-back.)

It is indeed singular how this species, so abundant in our woods thirty or forty years ago, has, without any apparent cause, so completely disappeared from the North Island. It still exists, but in sadly diminished numbers, in the South Island; so also does *Creadion cinereus*. During two visits to the West Coast Sounds I was only able to obtain one specimen of each species. I sought in vain for skins at the various dealers' shops I visited. I believe the current price now is a guinea, and in a few years' time it will be impossible to obtain specimens at any price.

Speaking on the subject to old Ihaka, of Ngatiwehiwehi, he said, "Oh, yes; when I was a young man the woods about here [Manukau] were swarming with these birds; also with Kotihe, the Whiowhio, the Pitoitoi, and the Popokatea. Now they are all gone—as completely as the moa! Soon also will my race vanish from the land, and the white man, with his sheep and his cattle and his birds, will occupy the country!" This was Ihaka's simple way of formulating the doctrine of the survival of the fittest.

Myiomoira macrocephala, Gmelin. (South Island Tomtit.)

In a thick clump of *Olearia rotundifolia*, at Stewart Island, I saw a lovely albino of this species. I brought it down with a small charge of dust-shot, but unfortunately lost it in the

close vegetation, although I spent a considerable time hunting for it.

Sphenœacus punctatus, Quoy and Gaim. (Fern-bird.)

I have lately noticed, at Papaitonga, that this species has a habit of hopping over the ground to feed under the thick marsh vegetation. This may probably account for the usually abraded condition of the tail-feathers at the close of the season.

As mentioned on a previous occasion, I have received from Stewart Island two skins (male and female) that seem to represent a larger race—possibly a distinct species—but I am anxious to procure more specimens before forming any definite conclusion. This bird is darker than the common Fern-bird of the mainland, the whole of the foreneck and throat being thickly studded with black spots. These black markings become more conspicuous on the breast and sides, occupying the whole centre of the feather.

Sphenœacus rufescens, Buller. (Chatham Island Fern-bird.)

I have in my possession a partial albino of this now very rare species from the Chatham Islands.

Anthus novæ-zealandiæ, Gmelin. (New Zealand Pipit.)

Mr. Langley, of Foxton, has forwarded to me for examination the skin of a pure albino of this species, very skilfully prepared by himself. There is also another perfect albino in the Colonial Museum collection, obtained, I believe, in the Hawke's Bay District.

I notice that Captain Hutton, when exhibiting to the Philosophical Society of Canterbury an albino Skylark, referred to it as the first example of the kind obtained in New Zealand. This is not exactly the case, however, for in 1886 I received two specimens from Mr. W. W. Smith, of Ashburton. One of these I presented to the British Museum and the other to the Cambridge Zoological Museum. The fact is interesting in itself, as showing the strong tendency to albinism in this country even among introduced birds.

Rhipidura fuliginosa, Sparrm. (Black Fantail.)

At Half-moon Bay (Stewart Island) I saw a Black Fantail paired with a Pied Fantail, the former looking, as it moved about among the twigs on the roadside, half as large again as its mate. *Rhipidura flabellifera* is the common species on the island, there being only stray individuals of the black form.

Rhipidura flabellifera, Gmelin. (Pied Fantail.)

One has to speak of so many of our species as decreasing, or as having reached the border-land of extinction, that it is quite refreshing to be able to record that the Fantailed Fly-catcher—that pretty little denizen of our woods—is perhaps more plentiful than ever; at any rate, it shows no sign of diminution. Mr. Robert Mair, writing to me from Whangarei on the 11th September, says, "I saw a pleasing sight a few weeks since. There are generally five or six Fantails flitting about our shrubbery in the evening, catching gnats in the air and diverting one by their fantastic aerial evolutions. But on this particular evening I counted no less than twenty-five of them at one time."

I never see this little bird, or hear its "laugh," without being reminded of the romantic Maori myth of Maui's disaster, which brought death into the world, when Hine-nuitepo, awakened by the merriment of the Tiwaiwaka, closed her mouth and put an end to Maui's ambitious dream of conquering man's last enemy. The story has been well told by Sir George Grey in his "Polynesian Mythology."

Graucalus melanops, Latham. (Australian Shrike.)

To the already recorded instances of the occurrence of this Australian species in New Zealand I have now to add another. Mr. William Townson writes to me that one of these birds was shot near Bradshaw's Creek, at Westport, some years ago, and came into Dr. Gaze's possession. Unfortunately, it was ultimately destroyed by moths.

Prosthemadera novæ-zealandiæ, Gmelin. (The Tui.)

A remarkable specimen which has come into my possession has the head, neck all round, the whole of the breast, and sides of the body umber-brown, the feathers of the breast having pale shafts; neck-frill very indistinct, being often reduced to mere shaft-lines of white; upper surface of body, wings, and tail creamy white, with a broad alar bar of pure white; thighs, abdomen, and upper and lower tail-coverts pale yellowish-brown; quills and tail-feathers umber-brown on their inner webs; neck-bands pure white; bill and feet horn-coloured.

A nest of this species (now in the Otago Museum) was found by our party fixed in the branches of a makomako (*Aristotelia racemosa*), about 12 ft. from the ground, at the head of Milford Sound. It is of symmetrical shape, and firmly put together, the outworks consisting of twigs and soft tree-moss, then a layer of fern-hair, and inside of this a lining of white feathers. Curiously enough, these are sea-birds'

feathers, the builder of the nest having evidently repaired to the shores of the Sound to collect them.

Anthornis melanura, Sparrm. (The Bell-bird.)

Mr. Robert Mair, writing to me from Whangarei, under date the 11th September, says, "I was out last week in a 6-ton yacht hapuku-fishing at the Poor Knights [in the Hauraki Gulf]. On the largest of the Poor Knight Islands there are numbers of Korimako. It was delightful to see them flying from bush to bush overhead, and to hear them singing their sweet notes."

From Mrs. Halcombe, a daughter of the celebrated ornithologist, the late William Swainson, F.R.S.,* I have received the following interesting note: "Bell-birds are very plentiful on the Island of Kapiti. I stayed there for nearly three weeks in 1894, and every morning, about 4 o'clock, I was charmed to hear a perfect concert from the Bell-bird. The house was quite close to a beautiful piece of bush, which was full of native birds, and, to judge from the noise they made, the Bell-birds must have been *very* numerous. . . . I have all the tastes of my dear father, but I have not had the chance to develope them. I cannot help loving all the beautiful world of nature, and I wish I had the time and opportunity to study all her wonderful secrets. The longest lifetime, it seems to me, is all too short for the full enjoyment of her treasures."

Anthornis melanocephala, Gray. (The Chatham Island Bell-bird.)

I have been fortunate enough to receive lately two beautiful pairs of this species from the Chatham Islands; but, according to all accounts, the bird is very nearly extinct there.

Zosterops cœrulescens, Latham. (The Blight-bird.)

The history of the arrival from the South Island and subsequent stay of this little migrant is familiar to all who know anything of our local natural history. Its services to the agriculturist and to the gardener are also pretty generally recognised. But one is always glad to record fresh evidence in favour of any deserving bird—especially, too, when there is a widespread prejudice abroad against little birds in general,

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* It was from Mr. Swainson that I received my earliest lessons in zoological drawing. He had long before published a beautiful series of "Zoological Illustrations" (1820–21). "All the figures were drawn by the author, who, as an ornithological artist, had no rival in his time. Every plate is not beyond criticism, but his worst drawings show more knowledge of bird-life than do the best of his English or French contemporaries." ("Dictionary of Birds," p. 28.)

and an organized crusade for their destruction. As an instance of this, I may refer to a newspaper paragraph to the effect that during a period of three months the Knapdale Road Board (Otago) purchased the large number of 56,612 birds'-eggs, for the purpose of destroying them. I am glad, therefore, to give the following from my excellent local correspondent, Mr. Robert Wilson: "The Blight-bird is undoubtedly on the increase in the Rangitikei district. They seem to have found a winter food in the introduced insects, and may now always be seen flying about the run in flocks. The food they are now chiefly subsisting on is a little caterpillar—a striped-green species, which does great harm to the crops in summer. These are now—September—to be found all over grass-lands—under logs, sticks, &c.—and the Blight-bird pursues them indefatigably. When I am working at a fence they will sometimes be within a couple of yards of me, searching every cranny for insects. They are particularly fond of diving out of sight into a common tussock (*Carex*), the plant which grows so freely on the hills, and they crawl about under any fallen scrub, looking for insects, and keeping up a pleasant cheeping all the time. I have sometimes seen them with a caterpillar nearly as big as themselves battering it against a wire on a fence till it was reduced enough to swallow. They must do immense service to farmers at this time of the year, as one caterpillar now means thousands in summer. As every one knows, it is very fond of the American blight, which is so destructive to the apple-trees. There is an orchard close to a patch of native bush on the farm, and the Blight-birds keep it entirely free from this pest. Though the blight sometimes, in hot weather, makes a start on the trees, in winter these birds always keep it under."

At Fiji I saw small flocks exactly resembling our Blight-bird in their flight and habits, but on shooting one I found that it was quite a distinct species. It has a more conspicuous eye-ring, with a beautiful lemon-yellow throat, and only the slightest indication of brown on the sides of the body.

Clitonyx albicapilla, Lesson. (The White-head.)

I am glad to be able to announce the recent appearance of a pair of this now rare species in the bush on the northern shore of the Papaitonga Lake.*

* Professor Newton accepts my suggestion that the disappearance of the White-head and some other New Zealand perchers is, in a large measure, a displacement due to the introduction of exotic birds, which, being morphologically higher and constitutionally stronger, speedily establish themselves at the expense of the lower, weaker, and earlier forms. ("Dictionary of Birds," p. 1087.)

Xenicus longipes, Gmelin. (Bush-wren.)

At Milford Sound I met with *Xenicus longipes*—a single one, which I managed to secure with a charge of dust-shot. The bird has a rapid, furtive way of moving about, keeping, as a rule, near the ground, and hunting for its food among the mosses and fungi covering the roots of the trees. When I first saw it, and excited its attention by an imitation of its feeble cry, it hopped about on a branch quite close to me, and several times opened its mouth, after the manner of a young bird, but without making any sound. It was very active, not remaining for one moment in the same position. It soon became indifferent to my simulated call, retired to some distance, then descended to the ground and hopped about, apparently looking for food, and moving so swiftly that I found it very difficult to get a shot. The specimen proved to be a young bird, but it has exactly the same colours as the adult, although somewhat duller. In this respect it differs from the allied genus, *Acanthidositta.*

Mr. Brough, to whom I was indebted for some beautiful specimens of the Bush-wren some years ago, writes giving me an account of a subsequent visit to the locality whence he obtained these birds—the low woods under the Tasman Range. He says: "When I went back this year I pushed on to a spot a few miles further on than where I camped before. I am sorry to say that the Bush-wren and the Wood-robin had almost entirely disappeared. I am certain I did not see more than a dozen during the several months I was out. The heavy falls of snow last winter may have been the means of killing off a number of these birds, or the wet summer may have induced them to migrate to some drier woods at a lower altitude; but, whatever the cause may be, they are gone. Whilst I was there we had an immense and continuous fall of rain, and the bush was never dry. We had twenty-six wet days in January, and during the whole time of my stay it was mostly wet, with very little sunshine. The Wood-robin, which was formerly so plentiful there, has almost entirely gone. This is a great pity, because there is no bird more respected by the backwoodsman than this one. There is nothing else to relieve the monotony of these gloomy red-birch forests. Their raillery, if I may so term their string of noisy notes, brings the explorer suddenly up when he is rambling alone in these mountain solitudes, and produces a feeling of companionship. The absence of this sprightly bird was, I may say, the saddest feature of my four months in the wet and lifeless forest."

Eudynamis taitensis, Sparrm. (Long-tailed Cuckoo.)

On the 8th June I received from Mr. H. H. Travers a note saying that he had just obtained from New Plymouth, in the

flesh, a Koheperoa in very fat condition. Very late in the season for such a bird! Mr. Travers suggests that some may remain with us all the year round. It may be so, but the occurrence is a very unusual one. It is clear, however, that there is no lack of winter food for this species. And if it is able to endure our seasonable cold, why should it have inherited its wonderful migratory instinct? This is one of the problems of natural history which will probably never find a solution. Why should the Godwit make its annual weary pilgrimage from New Zealand to Siberia, when, as we know, the few individuals that remain with us through the winter are always fat and in good condition?

Nestor meridionalis, Gmelin. (Var. Kakakura.)

A specimen in Mr. Whaley's collection obtained at Rotorua differs from all examples I have seen in having the hindneck greenish-orange with black centres to the feathers; the crown of the head, cheeks, and throat dusky-brown, the ear-coverts being dull orpiment-orange; breast dusky-brown, mixed with yellow; shoulders bright-scarlet, mixed with orpiment-orange, the centres of the feathers brown; croup and upper tail-coverts brilliant scarlet, with clouded markings of brown; abdomen, flanks, and under tail-coverts duller scarlet, largely mixed with brown; upper surface of wings beautifully varied with olive-brown, scarlet, and orpiment-orange; lining of wings golden-yellow towards the bend, pale-scarlet below; quills golden-yellow and scarlet for half their extent, then dusky to the tips; tail-feathers pale-scarlet for two-thirds of their length, then dark-brown, with naked shaft-lines produced ½ in. beyond the webs.

On the table this evening there is another very similar specimen exhibited by Mr. Donne, who is making a collection of New Zealand rarities.

On the occasion of a visit to Stewart Island I obtained from a settler named Jensen a beautiful albino (or, rather, buff-grey) example of this species. On inquiring how he got it, he explained that, being out in the woods Kaka-shooting, he wounded a bird, and, without looking closely at it, he held it down with his foot as a decoy. Its screams attracted a flock of them, and, in quick succession, he shot fifteen. Then he took up his wounded bird and found that it was something out of the common. The specimen was successfully skinned by Marklund, and I rewarded Jensen liberally for saving it.

Stringops habroptilus, Gray. (The Kakapo.)

It is gratifying to learn that the Kakapo is still plentiful in the wooded country on the west coast of the South Island, in spite of the steady spread of stoats and ferrets; but in former times they were, of course, far more abundant.

Canon Stack, in his very interesting account of the original occupation of certain districts by the Ngaitahu, refers thus incidentally to the home of the Kakapo:* "These young chiefs (known as the Whanaunga-purahonui), having ascertained from persons familiar with the physical features of the country the names of the various localities, proceeded to divide the unallotted parts of the country amongst themselves; and their procedure on this occasion is of particular interest, as it serves to illustrate one method by which the Maoris acquired title to land. Kakapo-skins were at that time highly prized, and every one of the party was desirous to secure a parrot preserve to himself. As they approached the mountain known as Whata-arama they each claimed a peak of the range. 'That is mine,' cried Moki, 'that my daughter Te Aotukia may possess a kilt of Kakapo-skins to make her fragrant and beautiful.' 'Mine,' cried Tanetiki, 'that the Kakapo-skins may form a kilt for my daughter Hinemihi.' 'Mine,' cried Hikatutae, 'that the Kakapo-skins may form a girdle for my daughter Kaiata.' Moki, one of the party, had his servant with him, who whispered in his ear, 'Wait; do not claim anything yet'; and then the man climbed up into a tree. 'What are you doing?' said the rest of the party. 'Only breaking off the dry branches to light our fire with.' But he was in reality looking out for the mountain which Tura-kautahi had told his master was the place where the Kakapo were most abundant. Presently he espied the far-off peak. 'My mountain, Kura-tawhiti!' he cried. 'Ours!' said Moki. The claim was at once recognised by the other members of the exploring expedition, and Moki's descendants have ever since enjoyed the exclusive right to catch Kakapo on Kura-tawhiti."

Professor Newton, in his "Dictionary of Birds," writing of this species, corrects a current statement that in this form of Parrot the furcula has been "lost," whilst the sternum lacks a keel, and he explains that whereas the clavicles, which in most birds unite to form the first-mentioned bone, are present, though they do not meet, on the other hand the keel on the sternum is undoubtedly present, and, though much reduced in size, is nearly as much developed as in the Dodo and the Weka. He adds (p. 474): "Yet, though much has been written about the Kakapo, there is no detailed description of its internal structure, a fact the more to be regretted since the bird is obviously doomed to early extinction, and the opportunity of solving several problems of interest, which a minute examination of its anatomy might afford, will be lost if the matter be not speedily taken in

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* "South Island Maoris," by Canon Stack.

hand. Few existing birds offer a better subject for a monographer, and it is to be hoped that, if perish the genus and species must, posterity will not have to lament the want of an exhaustive treatise on the many and wonderful characteristics of what Professor Fürbringer considers* to be one of the primitive forms of *Psittaci*." I would venture to remark that the absence of so desirable a monograph can hardly be due to the want of material. Years ago I presented to the British Museum a perfect skeleton of the Kakapo, and another to the Cambridge University Museum. I also forwarded to London a specimen, in spirits, for the express purpose of having its anatomy investigated.

Spiloglaux novæ-zealandiæ, Gmelin. (The Morepork.)

I have recorded in my "Birds of New Zealand" a partial albino of this little Owl. An intelligent young half-caste informs me that he saw a snow-white one at the Bay of Islands. It was in the day-time, and he followed it a considerable distance through the woods, hoping to secure it, but without success.

Circus gouldi, Bonap. (Gould's Harrier.)

I have to record a beautiful albino of this species that was taken alive—shot in the wing—in the Canterbury District last summer. In this bird the entire plumage is snow-white, except that on the upper surface there are a few scattered brown feathers on the shoulders, two among the small coverts of the right wing, and one or two partially brown feathers among the scapulars; also, on the under-surface, one of the axillary plumes, one of the under-coverts of the left wing, and a single feather on the left thigh are brown, and there is a wash of fulvous on the abdomen. The tail, however, is of the normal colour, but one of the feathers is white on its inner vane. With these trifling exceptions, the entire plumage is snow-white, presenting a very striking appearance. On dissection it proved to be a female, and its golden irides showed that it was an adult bird.

It must have been such a bird as this which the old *tohunga* had in his mind when he narrated to Sir George Grey, "on the rocky edge of a hot spring shaded by pohutukawa-trees," on the Island of Mokoia, the story of Hinemoa, the maiden of Rotorua:—

> She rose up in the water
> As beautiful as the wild white hawk,
> And stepped on the edge of the bath
> As graceful as the shy white crane.

* Journ. für Orn., 1889, pp. 239–241.

As I have remarked before, this species appears to be steadily increasing, notwithstanding the numbers that are annually, and, as I think, very unwisely, destroyed by sheep-farmers. One reason for this, no doubt, is that they are not preyed upon by the introduced pests. On the contrary, they do not hesitate to attack stoats and ferrets when they have the chance. Judge Gill told me of a combat which he witnessed between a Harrier and a stoat, in which the latter was eventually killed, although the Hawk found it too heavy to carry away with him.

In its progress towards maturity the Harrier passes through several phases of plumage, and is sometimes very beautifully marked. At Papaitonga I shot an adult male which was molesting my Teneriffe Quail. It was in excellent plumage, with a very distinct white frill on the lower part of the throat, and having the under-parts of the body tawny-white, stained with fulvous, and marked with broad longitudinal streaks of dark-brown, presenting the appearance of a buzzard on the under-surface; lining of the wings white, with narrow longitudinal streaks of brown; the axillary plumes pure white, with broad transverse bars of rich umber-brown; and the superior under wing-coverts crossed by numerous arrow-head patches of the same; the inner webs of the quills pale cream-colour; and the upper wing-coverts marked with a spot of rufous, more or less distinct, near the tip. Irides pale-yellow, and of sparkling brilliancy; legs rich lemon-yellow, brightest on the toes; claws black.

I have noticed that this species hovers and hunts in the rain, without any inconvenience, occasionally shaking its wet plumage.

Carpophaga novæ-zealandiæ, Gmelin. (New Zealand Pigeon.)

To the numerous varieties of this species already described I have now to add another, recently procured through Mr. Jacobs, of this city. General plumage delicate cream-colour; under-surface pure white, the line of demarcation on the breast being quite distinct; nape, shoulders, interscapulars, and small wing-coverts rich chocolate-brown, forming a very conspicuous mantle; bill and feet carmine.

A Maori at Otaki had a tame bird of this species in his possession for many months. It had the freedom of a large hut, where I saw it, and would perch on the hand or shoulder in the most confiding manner. In the end it was killed by one of those mongrel curs that infest every native village. I also had one confined in an aviary for some months, intending to forward it to the Zoological Society of London; but, unfortunately, some children, taking compassion on the bird's soli-

tary appearance, deliberately opened the door and turned it loose. This Pigeon had been brought in by a party of bush-fellers, who reported that it was stunned by becoming entangled in the branches of a falling tree. It seemed quite unhurt, and adapted itself readily to captivity, feeding freely on wheat, cooked potato, and almost anything offered to it. It consorted with a tame Silver-runt, confined with it. The latter laid two eggs, but they proved to be infertile.

The protection extended to this bird by the Legislature, in having every sixth year made a close season, is a great boon, and will save this fine Wood-pigeon from the extermination which lately threatened it. The fact of a species being very plentiful is no guarantee against its speedy extinction when once the tide of destruction has set in. Of this it would be easy to adduce numberless proofs from all parts of the world. But protection at the right moment may achieve a good deal in the way of arresting the evil. An intelligent old man of the Ngati-wehiwehi Tribe said to me in February, "The Pigeons are coming back to us. Soon they will be as plentiful as ever. [As we spoke five of them passed in sight, each winging its solitary flight.] Now they are good eating. In January they have the early miro. This lasts through February. Then they get very fat and sweet. In March the food is scarce. In April the second crop comes on, and then the birds get fat again." Tamihana Whareakaka, who was present, chimed in, "Oh, yes; how fat the Pigeons were in the old days, when we used to go out and trap hundreds of them! Kakas, too, were plentiful. These are disappearing, because the introduced bees have taken possession of the hollow trees. That can't be helped," added he; "but what is the use of the Government protecting the other birds and imposing fines and punishments if they allow all the woods to be destroyed, for how is the Pigeon to find subsistence when the berries are gone?" There is some philosophy in Tamihana's words, but I fear it is a poor argument against the requirements of advancing settlement. The only thing to be done is to insist on ample bush reserves being set apart.

Himantopus leucocephalus, Gould. (White-headed Stilt-plover.)

Mr. Robert A. Wilson, of Bull's, writes me, "Both the Pied Stilt and the Red-breasted Dottrel nest freely on the river-bank here [Rangitikei]. They build very low, and their nests are often, on that account, destroyed by floods. One pair of Stilts had their nest destroyed three times in succession in one year, but they formed a fourth, and reared a brood."

Glareola grallaria, Temminck. (Australian Pratincole.)

Regarding the occurrence of this widely spread species, I have received the following particulars from Mr. William Townson, to whom the specimen belongs: "The bird was first seen by Mr. J. B. McKenzie, an agent for the National Mutual Life, and he came back from the beach for a gun, and on his return shot the bird and brought it to me. I remembered seeing either the bird or a plate of it, and on turning up the 'Royal Natural History' I found an illustration of it, and a pretty full description. The hind-toe, forked tail, and the black line bordering the buff-coloured throat are sufficiently distinctive, the only point omitted in the description being the scarlet margin to the gape. The bird was seen hawking after flies on the beach. It proved to be a male, and the stomach contained the remains of insects and beetles. It seemed quite at home with its surroundings, and I found it in perfect plumage, without any stains of travel or any marks of having been in confinement—so different from an Australian Curlew in my possession, which was shot on the same beach, and which was ragged and frayed out as though it had been beating up against head weather for a week. Two years ago I was at Mokihinui, and saw a couple of Australian Tree-swallows hunting flies about the head of an old rata in a bush-clearing. I watched them for some time, but did not manage to get a specimen."

Writing of this species, in his "Birds of Australia," Mr. Gould says it "possesses several remarkable specific distinctions, the great length of the tarsi and primaries, which, combined with the graceful contour of its body and the small size of its head, render it the most elegant species of the genus that has yet been discovered."

Stercorarius crepidatus, Vieill. (Richardson's Skua.)

Mr. A. T. Pycroft sends me the following interesting note from the Bay of Islands: "Skua-gulls are sometimes seen here in the summer. Only a fortnight ago, when I was out fishing at the Rawhiti, I saw three of these birds. As a rule, I have found them following flocks of the Antarctic Tern, when the latter are fishing. The Skua singles out a Tern which has a fish, and frightens it so that the Tern cries out, and, as a rule, drops the fish; then the Skua, with great quickness, secures the prize before it reaches the water. While this is going on some of the other Terns fly round the assailant screeching, but they do not venture to attack it. Shortly after I came here, when pulling up the Waikare River, I saw a Tern trying to evade the attack of a larger bird of dark plumage; however, the poor Tern had no chance against its powerful enemy, who struck it, causing it to fall

into the water. I was surprised to see the assailant settle down in the water and lift up the Tern, flying off with it about 200 yards, when it was dropped. I pulled up, and on my approach the large bird flew away The Tern was quite helpless when I picked it up, but came to later on; however, it died next morning. I think the bird that struck it was a Skua-gull, but of this I am not certain." Probably the larger form, *Stercorarius antarcticus*.

I have recorded several instances of the occurrence of this species in Wellington Harbour. The last specimen that came under my notice (an adult bird) was taken on the Wairarapa Lake.

Sterna nereis, Gould. (Little White Tern.)

A pair of this somewhat rare species frequents the Papaitonga Lake, but only in rough weather. In January I saw a pair at the Wairoa Heads. They were fishing in roughish water, and very near the surface. This bird does not appear to be gregarious like the other members of the genus. I have never seen more than a pair together.

Notornis hochstetteri, Meyer. (The Moho, or Takahe.)

I have already dwelt upon the recent capture of *Notornis* as an event of exceptional interest. It is curious to find the following reference to its haunts in Canon Stack's history of the now extinct Ngatimamoe Tribe of Maoris: "A party [of Ngaitahu] had been sent from Pukekura to Rauone to collect fern-root. One of them, Tane-toro-tika, the son of Taoka and grandson of Manawa, a young chief of very high rank, was surprised and taken prisoner. On being carried to the presence of Te Maui, that chief, seeing him, said, 'This comb-fastening is equal to that comb-fastening,' meaning that the captive's rank corresponded to that of the chief whose remains had been desecrated, and thereupon killed him. Taikawa, a Ngaitahu warrior, immediately after the deed, came upon the band of Ngatimamoe, and asked them what had become of their prisoner. When told that they had killed him, he said, 'You have done foolishly, for not a soul of you will now be spared. You will be banished to the haunts of the Moho (*Notornis*), and in the depths of the forest will be your only place of safety.'" Taikawa's words were prophetic, for, notwithstanding the persistent rumours of wild men in the woods of the West Coast, the capture of a Ngatimamoe would be a greater event even than the killing of a *Notornis*.

Rallus philippensis, Linn. (Banded Rail.)

During my last visit to Fiji, when out shooting on the Island of Wakaya, I heard the unmistakable note of this

species. I also received two skins from one of the other islands of the group. They differ from the typical form in the more spotted character of the wings and in the total absence of the chestnut-coloured pectoral band.

Ocydromus earli, Gray. (Brown Woodhen.)

Having sent Professor Newton a specimen of the Woodhen from the west coast of the south Island, which I had identified as the true *Ocydromus earli,** he wrote me as follows: "I have been much struck with the Weka, named on the ticket *O. earli.* Last summer I made a pretty elaborate examination of the fairly good series of specimens of the genus we have now here (thanks to yourself, Hector, and Von Hügel), and I feel that we (or, at least, I) have not got to the bottom of the business yet, though I believe that what I have said in the 'Dictionary of Birds' (p. 1032) is pretty correct so far as it goes. I find it hard to bring myself to think that there were three distinct species in the South Island; but sooner or later this dark point will be made clear, and it would be well that it should be so. What a fine opportunity there is for some one to write a monograph of *Rallidæ.* In regard to *Ocydromus* only, my investigation last summer had produced on me the impression that I had been able to see daylight, but this last specimen of yours has almost shattered that hope."

Ocydromus greyi, Buller. (The North Island Woodhen.)

Mr. Robert A. Wilson, to whom I am indebted for some beautiful specimens of this bird, writes to me: "Unlike the stupid Stilt-plover, the Woodhen, which also lives in the bottoms of creeks, nearly always nests in a single raised flax-bush some distance above the flood-mark. When looking for eggs, if you walk along a creek and examine the bushes standing by themselves, higher than the rest, you will sometimes find nearly every suitable one occupied. On our run about one pair of Woodhens occupy about 300 to 400 yards of creek-bed, and you never find more than one pair in a section. Our creeks are all covered at the bottom with thick flax, and the Maoris have specially trained dogs to catch them in these localities. The man rides along the creek, while the dog trots along unconcernedly in the midst of the flax. When he arrives opposite a Woodhen's home he stops and dashes in, then he as suddenly rushes out and runs ahead of the Woodhen, which has, of course, started up the creek; then he turns and meets the bird, of which he makes a short business. A dog that did not understand his work would lose much time—first in search-

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* "Birds of New Zealand," 2nd ed., vol. ii., p. 115.

ing the ground, and then in chasing the bird along the creek-bottom, where it could travel faster than its pursuer.'

This note is interesting in itself, and, moreover, shows that this species is still plentiful, in the Rangitikei district at any rate. I have always known the male birds fight vigorously for their rights; but in Mr. Wilson's district they appear to have a recognised territorial partition. Birds that are developing so much intelligence surely deserve a better fate than to be collected by a naturalist or consigned to the Maori pot.

But the Woodhen fights on very unequal terms with its new enemies—stoats and weasels. That the introduced carnivora continue to do untold mischief is beyond question. In the *New Zealand Herald* I find the following paragraph on this subject: "Scarcely a day passes but what we hear some news of the depredations by weasels in one part or other of the district. Several deaths among sheep have been reported in the Hautapu district lately, and on Thursday last Mr. Ward lost three fine ewes. The deaths in all cases were attributed to weasels."*

* My own views as to the absolute wickedness of introducing these predatory animals into this fair land of ours are too well known to need repetition. But I should like to quote here what Professor Newton has to say on the subject: "In respect of extermination leading immediately to extinction, the present condition of the New Zealand fauna is one that must grieve to the utmost every ornithologist who cares for more than the stuffed skin of a bird on a shelf. In the fauna of that region the class Aves holds the highest rank, and, though its mightiest members had passed away before the settlement of white men, what was left of its avifauna had features of interest unsurpassed by any others. It was, indeed, long before these features were appreciated, and then by but few ornithologists, yet no sooner was their value recognised than it was found that nearly all of their possessors were rapidly expiring, and the destruction of the original avifauna of this important colony, so thriving and so intellectual, is being attended by circumstances of extraordinary atrocity. . . . Allowing for a considerable amount of exaggeration on the part of the sheep-owners, no one can doubt that the rabbit plague has inflicted a serious loss on the colony. Yet a remedy may be worse than a disease, and the so-called remedy applied in this case has been of a kind that every true naturalist knew to be most foolish—namely, the importation from England and elsewhere and liberation of divers carnivorous mammals—polecats or ferrets, stoats, and weasels. Two wrongs do not make a right, even at the Antipodes, and from the most authentic reports it seems, as any zoologist of common-sense would have expected, that the bloodthirsty beasts make no greater impression upon the stock of rabbits in New Zealand than they do in the Mother-country, while they find an easy prey in the heedless and harmless members of the aboriginal fauna, many of whom are incapable of flight, so that their days are assuredly numbered. Were these indigenous forms of an ordinary kind their extirpation might be regarded with some degree of indifference; but, unfortunately, many of them are extraordinary forms —the relics of perhaps the oldest fauna now living. Opportunities for learning the lesson they teach have been but scant, and they are vanish-

Ardea egretta. (White Heron.)

On my visit to Paterson's Inlet (Stewart Island) I saw a beautiful White Crane, which, it was said, had been frequenting that locality for ten or twelve years. We found him perched among, or very near to, a colony of Pied Shags, which were nesting in a tree "rookery," but the vigilant bird took alarm and sailed away long before our boat had reached the spot, or the Shags, ever on the alert, had shown any sign of uneasiness. We saw him later on in the day, on the other side of the cove, perched high up on a rimu-tree, and looking very conspicuous among the surrounding vegetation; but, although it was fully a quarter of a mile off that our boat landed, the bird took alarm and was off again. I was amused and pleased at the objection of the lad who rowed me to any attempt being made to shoot the Crane, because, as he put it, "We've seen him here ever so long."

About six months later an ardent collector, after much careful stalking, shot this beautiful Crane, and sent me the skin. I purchased the specimen, but wrote to my correspondent expressing my regret that he had interfered with this particular bird. In his reply he said, "If I had known so much of the history of this Crane as I know now I never would have shot it." It proved to be a female, and at the time it was killed—the month of August—it had no dorsal plumes.

It is an interesting sight to watch this stately bird fishing. It wades into shallow water, as far as its long legs will enable it, and then it remains perfectly motionless till its prey comes within reach, when it will strike forward with the rapidity of an arrow, seize it with its powerful yellow mandibles, and instantly swallow it. It is quite possible, as suggested by the Duke of Argyll in the case of an allied European species, that the small fish are attracted by the gleaming reflection in the water of the bird's snowy plumage.

The mention of this solitary Kotuku in Stewart Island reminds one of a passage in Canon Stack's interesting brochure, already referred to: "In his island home at Rakiura (Stewart Island) Kana te Pu dreamt that he caught a White Crane, which kicked him in the chest while vainly struggling to get free. Interpreting this dream to mean that he was

ing before our eyes ere that lesson can be learnt. Assuredly the scientific naturalist of another generation, especially if he be of New Zealand birth, will brand with infamy the short-sighted folly, begotten of greed, which will have deprived him of interpreting some of the great secrets of nature, while utterly failing to put an end to the nuisance—admittedly a great one. The provoking part of the thing is that, as shown by Mr. Sclater ("Nature," xxxix., p. 493), there exists a way, the discovery of Mr. Rodier, at once simple, natural, and efficacious, of reducing the rabbit-pest." ("Dictionary of Birds," pp. 224–225.)

destined to overcome some famous Ngaitahu warrior, he went to a neighbouring stream to bind the omen, and then, eager to distinguish himself, summoned his followers, and took his departure for the seat of war. In the crisis of the battle, when Rakautauwheke was slaying those to the right and left of him with his taiaha, Kana te Pu, watching his opportunity, sprang upon his shoulders, and held him so firmly that he could not draw his arms back again. He tried in vain to shake him off, but by a sudden movement of his hands he jerked the point of his weapon against the head of his opponent, and then, by a violent contortion of the body, succeeded in inflicting a mortal wound, and the 'White Crane' fell dead at his feet."

Ardea cinerea, Linn. (The Common Heron.)

This cosmopolitan species has been met with in all suitable localities throughout the whole of Europe, Africa, and Asia, reaching Japan, many of the islands of the Indian Archipelago, and even Australia. In the latter country it is evidently very rare, for Mr. Gould only saw it once in the course of his explorations. He says, "During my journey into the interior of South Australia, in 1839, I saw a fine example of this bird, but, although I resorted to every possible stratagem in my power to get within shot of it, I regret to say I was unsuccessful. I have since, however, received a skin direct from New South Wales. Mr. Blyth considers that this Heron is not specifically distinct from the *Ardea cinerea* of India and Europe; and, if this be really the case, the species enjoys a very extensive range over the whole world."

We have now to include New Zealand in the range of this noble bird, Mr. A. Waley having obtained in Auckland the skin of one which was caught on board a schooner off the east coast, about the authenticity of which there can be no doubt.

Phalacrocorax onslowi, Forbes. (Chatham Island Shag.)

I have now before me two specimens of the Chatham Island Shag, which Dr. Forbes distinguished from *P. imperialis* under the above name. I find that, although the plumage is similar to that of the Stewart Island bird, it differs in having a cushion (if I may so term it) of red caruncles on each side of the forehead. In *P. carunculatus,* from Queen Charlotte Sound, these caruncles are orange-coloured. The male bird has a much broader and more conspicuous white alar bar than the female, and it exhibits a broad white dorsal spot, which is entirely absent in the other specimen. I may add that the latter has some beautiful white filaments at the back of each eye.

Phalacrocorax punctatus, Sparrm. (Spotted Shag.)

Mr. H. H. Travers states, in one of his published notes, that the female of *Phalacrocorax punctatus* is never crested; but this is a mistake. Both sexes are crested during the breeding season, although I think it is probable that the female does not assume the crest till the second year. Mr. W. Smyth has several female birds in full crest, and he assures me that he "sexed" them very carefully. In the female the colours are duller than in the male, the crests appear to be smaller, and the white-necked stripes are not so broad or conspicuous as in the male; otherwise the sexes are alike.

Phalacrocorax melanoleucus, Vieill. (The Frilled Shag.)

In October last I received from my son—who had shot it in the Papaitonga Lake—a small Shag which is undoubtedly referable to the above species. It possesses a conspicuous frontal crest, composed of very narrow feathers of a maximum length of 1 in. There is also an elongation of the feathers of the occiput, standing erect like a short mane, and the white feathers of the face and throat are produced so as to form a sort of irregular frill. The whole of the under-parts with the exception of the under tail-coverts, which, like the upper surface, are black, are of the purest white with a glossy surface; but on one side of the body there is an indistinct patch of black, showing that this was the earlier plumage. The bill is brownish-black on the ridge, the cutting-edges of both mandibles and the unguis being bright-yellow; sides of lower mandible and angles of the mouth yellowish-green, changing to dull-yellow on the eyelids; palate and throat pale bluish-green; inside of both mandibles bright-yellow. The feet have a rough surface, having the appearance of dull-black velvet. It proved on dissection to be a female, and it gave the following measurements: Approximate length, 24 in.; wing from flexure, 9·25 in.; tail, 6·5 in.; bill, along the ridge, 2 in., along the edge of lower mandible, 2·5 in.; tarsus, 1·5 in.; longest toe and claw, 2·5 in. The bird had been frequenting the lake for two or three years, disappearing at intervals, but it was so extremely shy that it was almost impossible to get a shot at it, except by stratagem.

This form is extremely rare in the North Island. I remember, when crossing the Otaki River on horseback, some thirty years ago, seeing one perched on a rock in the shallow water. At a distance of some 40 yards I could plainly distinguish the frontal crest, which the bird erected the moment it became alarmed by my presence.

Phalacrocorax novæ-hollandiæ, Stephens. (Sea-shag.)

When I was at Papaitonga last Christmas the mill-hands were felling some lofty rimu-trees on the northern side of the lake—15 or 20 chains from the water—on which the Sea-shags have for many years past had their "rookery." I regretted very much to see these trees come down, but they were beyond my boundary, and I could not interfere. The young birds had not yet quitted their nests, although they were well advanced—covered with thick black down, and with quills and tail-feathers several inches long.

Phalacrocorax varius, Gmelin. (Pied Shag.)

On my last visit to the Bay of Islands—in September—I was struck with the scantiness of bird-life. Here and there a solitary Sea-gull was to be seen floating on the surface of the water, and as we steamed up to Russell in the tender we saw a few Pied Shags: that was all. Of the latter there was a young one near the landing-wharf which continued to fish within a few yards of the boat during the whole of our visit, lasting a couple of hours. Timing it with a stop-watch, I found that each dive occupied, as a rule, thirty seconds.

Dysporus serrator, Gray. (Gannet.)

Captain Waller, of the "Anglian," tells me that in muggy weather he always finds the Gannet on the wing an infallible sign that he is nearing the Three Kings. On one occasion, however, he saw three of them when upwards of two hundred miles from land, and the occurrence was so unusual that he made an entry of it in his log.

Tachypetes minor, Gmelin. (Small Frigate-bird.)

Among the collection of New Zealand birds in the Colonial Museum is a locally mounted specimen of this bird, but I have been unable to ascertain its history. The only other New-Zealand-killed one, so far as we know, is in the Nelson Museum, where it has been for nearly forty years.

Tachypetes aquila, Linn. (Great Frigate-bird.)

Of this closely allied species the Colonial Museum contains the specimen captured at Castle Point and mentioned in my "Birds of New Zealand" (vol. ii., p. 185). I have recorded another which killed itself against one of the southern light-houses, and was brought to me by Captain Fairchild.

This "vulture of the sea" has a tropical range, and is comparatively abundant in the Fiji Islands. Whilst staying with my friend Captain Langdale, at Wakaya, I had frequent opportunities of observing it soaring overhead, singly or in pairs, its beautiful white throat gleaming in the sunlight, and

its long forked tail being alternately opened and closed like a pair of shears. It has marvellous powers of flight, and when soaring there is scarcely any visible movement of the wings, but there is a rapid movement of the head, first to one side, then to the other. When in pursuit of its victims, to compel them to disgorge, the whole character of the bird is changed; but I had no opportunity of witnessing this, the sea being too calm for fishing. Captain Langdale informed me that a few days before my visit he shot one with his rifle at a considerable altitude, and it came down with a crash on the roof of his house.

Diomedea regia, Buller. (The Royal Albatros.)

As we left the New Zealand coast (on the 11th September) for Fiji several birds followed our steamer all day, although it was perfectly calm. One fine *Diomedea regia*—readily distinguishable on the wing from *Diomedea exulans* by the splash of white on the humeral flexure—several of the latter, and also of *Diomedea melanophrys*, were in our wake till nightfall. There were two or three of the Giant Petrel and a few Cape Pigeons. It was a pleasant diversion to watch their aerial movements from the deck of the steamer, and it seemed to me that *Diomedea melanophrys* was decidedly the smartest and handsomest of the whole group, its movements on the wing being peculiarly light and graceful. On the following morning, with a gentle trade-wind blowing, a single Albatros appeared for a short time, and another swept over our stern at noon, and then winged its way off into the watery expanse. And we had not another glimpse of bird-life till we approached the coral reefs of Fiji. Of course, this in no way surprised us, because it is notorious that as we approach the tropics seabirds disappear. Captain Beaumont (of the s.s. "Flora") tells me that in winter he has sometimes carried the Albatros with him as far as the Tonga reefs, but never in the summer months.

Prion turtur, Kuhl. (The Dove Petrel.)

Mr. Lyall writes me from Stephens Island: "The Dove Petrels are here in thousands; the ground is covered with them as thick as they can find sitting-room. They begin to assemble as soon as darkness sets in, and the noise they make is something astonishing."

Œstrelata axillaris, Salvin.

A specimen of this rare Petrel, hitherto recorded only as from the Chatham Islands, was picked up, not long since, on the Wairarapa Plains, where also stray individuals of *Prion turtur* are often found, driven inland by stress of weather.

The plumage of this Petrel is so singularly like that of Prion that we may, I think, regard it as a case of mimicry for protective purposes. The two genera are perfectly distinct, but, as we get better acquainted with the species, we shall probably find that this Petrel hunts with the communities of Prion that are so common in our seas. What protection is gained in the struggle for existence by this curious resemblance of plumage can only be a matter of speculation till we know more about the habits and general economy of these birds.

Ossifraga gigantea, Gmelin. (Giant Petrel.)

Mr. Napier Bell, the well-known Civil Engineer, in a letter from Perth, Western Australia, says: "Two islands here are the home of the Giant Petrel. This bird is as large as a Goose, and of a dark slate-colour. I saw one which flew on board one of the dredges at Fremantle and dropped into the hopper, which is a great compartment where the dredge deposits its dredging; but, as this dredge is worked by suction from pipes laid to the shore, the hopper is unused, and full of water. The bird has lived there quite contentedly for a month, and refuses to leave the hopper. It is fed every day, swims about in the water, and roosts in the iron girders."

Puffinus tenuirostris, Temm. (Bonaparte's Shearwater.)

Mr. David Lyall, writing from Stephens Island, in September, says: "There is one Petrel here that I cannot find anything about in your 'Manual.' It is not so large as the Mutton-bird, and lays a pure-white egg, of the size of a common fowl's. The colour of the bird is dark-black, and white on the under-side. It has a call almost the same as that of the Laughing Jackass, of Australia. I will send you a pair of them." He kindly did so, and it proved to be the above species.

Puffinus griseus, Gmelin. (Sombre Shearwater.)

The late Dr. Shortland, nearly fifty years ago, published a graphic account of the "mutton-birding" operations of the Maoris in the South Island. These operations have been continued annually ever since, and it is a perfect marvel that the species continues to exist, in undiminished numbers, notwithstanding this wholesale slaughter. The last information I have on the subject is contained in the following newspaper paragraph: "The *Western Star* reports the arrival of a craft from the mutton-bird islands with the Riverton and Colac Bay contingent, which comprised seventeen families, numbering fifty individuals. The natives report that the birds were exceedingly numerous this season, and in splendid condition.

The catch of each individual, young and old, may be taken at the fair average of fifteen hundred birds, or a total of seventy-five thousand for the whole of the families. The average price is about 3d. a bird, so that the season's operations, when the birds are all sold, represents a total of £937 10s. Two Riverton girls are said to have made a record catch, taking four thousand two hundred birds between them."

Anas superciliosa, Gmelin. (Grey Duck.)

Mr. William Marriner informs me that on the Wairoa River, at the commencement of the shooting season, the Grey Duck is very fat and of excellent flavour, from feeding on the spawn of eels—tiny little crawling things that infest the mud-banks of the river in countless millions. On opening the birds at this season he has found their crops distended with this food alone, and there is every evidence that it is very nutritious.

The Grey Duck commences breeding on the Papaitonga Lake about the end of September, and the breeding season lasts till after Christmas. My son believes that this species brings out two broods in the season: he counted one clutch on the lake of eleven young ones.

Anas chlorotis, Gray. (Brown Duck.)

On the occasion of a recent visit to the Manawatu Gorge, I saw, in broad sunshine, a pair of these Ducks disporting themselves in a cool pool overhung with tree-ferns and other vegetation. But as a rule they remain in retirement during the day and come out at dusk. A Rangitikei correspondent informs me that this Teal has almost disappeared from that district. He adds, "As soon as they come out from their haunts, under the raupo in the swamps, they get shot. They are too simple for the changed times, and are fast succumbing to the inevitable." The last pair I obtained were shot by my son at Ohau. These were forwarded in spirits to Professor Newton, and enabled him to make an interesting discovery as to the affinities of this form with *Nesonetta aucklandica*, an account of which has already been communicated to the Society.

Casarca variegata, Gmelin. (The Paradise Duck.)

Professor MacGillivray said that *Casarca* may be termed with equal propriety a Duck or a Goose, and he demonstrated this by the anatomy of the bird. I may mention another point of similarity: the male of the above species hisses, when provoked, after the manner of the domestic gander.

Mr. Morgan Carkeek, who sent me some fine young Paradise Ducks from the Marlborough District in January,

states that, in his opinion, this species breeds twice in the year. He found it quite numerous in the mountain streams or river-beds, and met with many broods of young ones. He counted generally seven or eight, and on one occasion thirteen, in a clutch.

Formerly, however, it was far more abundant. Mr. McDonald, of Blenheim, informs me that in the old days he has known as many as five thousand taken in a single season. The numbers have been greatly diminished of late years by the laying of poisoned wheat for wild rabbits.

Rhynchaspis variegata, Gould. (Spoonbill Duck.)

A pair of these beautifully marked Ducks have nested for three successive seasons in the sedge near my boat-house on the Papaitonga Lake. This year the brood came out in the last week of November.

Podiceps rufipectus, Gray. (New Zealand Dabchick.)

This is one of the most interesting birds on the Papaitonga Lake, where it is extremely plentiful, as the result of close protection. A pair brought out their brood of five about the 15th December. It was very pretty to observe one of the old birds swimming over the smooth water followed by her little crowd of young ones, and then detaching herself for a time to gambol with her mate, and to skim the surface of the water, apparently in the height of playful enjoyment.

This bird is called "Taihoropi" by the Ngapuhi Tribe, "Weweia" by the Rotorua natives, and "Taratitomoho" in the Waikato.

Eudyptes chrysolophus, Brandt. (The Royal Penguin.)

I have lately had an opportunity of examining four curious specimens of this bird from the Macquarie Islands. Three of them are partial albinoes. No. 1 has the entire surface of the flippers and the whole of the body below their insertion white, tinged with cream-colour on the upper parts. There is no distinct line of demarcation against the dark plumage above the wings, but each feather has a brown centre, and this increases in extent till the darker plumage is reached; above the tail there are also a few touches of brown; and the tail-feathers, which are white, have brown margins; rest of the plumage normal, the golden-yellow on the forehead being extensive and very vivid. Nos. 2 and 3 have less white on the upper surface, the plumage of the back being pale yellowish-brown. The fourth specimen has a strong tendency towards melanism. On the right-hand side of the body there are large irregular patches of slaty-black feathers covering

about one-third of its extent. There is also a cloudy patch on the throat.

In two other examples submitted to me there are scattered feathers of the same colour on the under-surface of the body.

Apteryx mantelli, Bartlett. (The North Island Kiwi.)

I find in my diary a note which is worth recording, as showing the wonderful vitality of this species. I purchased a half-grown Kiwi, in vigorous health, which I decided to kill as a specimen. I adopted the usual means—compression of the breast-bone against the back. The Kiwi fought hard for life, but at length succumbed, and I laid it in a specimen-box, limp and lifeless, being to all appearance absolutely dead. In the evening I went to fetch my bird, intending to skin it, when, to my surprise, I found it alive and active, showing no sign of the tragic experience of the morning. I had not the heart to repeat the experiment, so I had a comfortable cage made for it, kept it for a month to accustom it to confinement, and then shipped it to England as a present to the Zoological Society, rewarding in this manner its heroic struggle for existence.

Apteryx occidentalis, Rothschild. (The West Coast Kiwi.)

I lately had an opportunity of examining some good examples of this species procured by an English tourist from a bird-dealer at Nelson. I remarked that the bill is very similar to that of *Apteryx oweni*, although the plumage, as already recorded, bears a general resemblance to that of *Apteryx haasti*, but is paler. Legs dark-coloured, in which respect it agrees with the latter; claws horn-coloured.

Apteryx haasti, Potts. (The Great Spotted Kiwi.)

I had six live specimens of *Apteryx haasti* in my possession for some time, and was much impressed with their gentle character as compared with *Apteryx mantelli* and *Apteryx lawryi*. Whilst they were in my enclosure—a period of a month or more—they never, so far as I am aware, uttered a single cry, in which respect they differed entirely from the other noisy species. They were very tame from the first, allowing themselves to be handled without much resistance. They had been caught in the wooded country near the Buller River, and were put straight away on meat-food in lieu of earthworms. Three of them pined away and died, having wasted to mere skeletons, being unable apparently to adapt themselves to the new and artificial conditions of life. The other three took readily to their new diet—raw minced beef and ox-heart—and became at the end of the month quite fat and heavy. I then shipped them to a friend in London, who received them in excellent health and condition.

Apteryx lawryi, Rothschild. (The Stewart Island Kiwi.)

Of this fine species the Colonial Museum contains a skeleton, but as yet no skin. I fortunately possess several skins, which were collected for me by a resident on Stewart Island prior to the issue of the Order in Council protecting this bird. Several skins and skeletons have been forwarded to Europe, but, so far as I am aware, no living example. Knowing that the Zoological Society of London was most anxious to procure this species, I instructed my agent to bring a pair in alive, which he succeeded in doing. The Kiwi having in the meantime become a "protected bird," I applied to the Government for the necessary permission under the Act, explaining at the same time that I had procured the birds at my own expense as a gift to a society of high scientific status, and one which has always been ready to do anything in its power to benefit New Zealand. I assumed, as a matter of course, that a permit would be granted; but, to my surprise and regret, our present Minister of Education considered it his duty to refuse my request, and I accordingly ordered the birds to be turned loose again. The inconsistency of the matter is that a brisk trade is going on in these birds under the very nose of the authorities—live ones from Nelson having lately been hawked about in Wellington—without any attempt to stop it.

My Stewart Island collector, Mr. O. Marklund, who is a very observant man, sends me the following notes: "At the end of July I came down from the hills; and on this trip I found that the Kiwis were moving down to the lower country —probably for nesting purposes. I should also mention— although it may be already known to you— that I have determined which of the cries are used by either sex. After some practice with a leaf of wild flax held in a certain position between my two thumbs I can fairly well imitate their cry. I have discovered that the best time for these birds is a moonlight night, with the sky somewhat overcast. If it is too light the birds will not leave the scrub. They also object to rainy weather. Though apparently insensible to pain when attacked by a dog, they are naturally very timid. If the moon is bright their own shadow will sometimes cause them uneasiness; indeed, I have seen one make a kick at its own shadow on the ground, accompanied by that peculiar hissing sound they make when confined in a pen. I have noticed also that a smaller bird will always run as hard as his legs will carry him at the least show of anger from a larger and stronger one. By imitating their cry—the deep rasping one being the more successful—I have always had the clear shrill one in response. If in the close neighbourhood, I would then send

the dog in, and it would always turn out to be a male. The male is generally ready to answer, especially if it does not happen to know where its mate is, but the female is more independent, and often takes no notice whatever of the call. With this bird the ordinary relationship between the sexes appears to be reversed; for instance, it is the female that undertakes the defence of the house and home, for the male gives in after a very slight struggle; but the male is the faster runner of the two. After the young is big enough to follow its parents the male (not the female) seems to take special charge of it. The male has a high shrill cry; the female utters a low hoarse note—between a cry and a hiss. In one case I heard the male uttering the cackling noise—like a hen with chicks—but that may be common to both sexes. Although a nocturnal bird, its sight is weak even at night, for I have seen them running against objects that could easily be avoided; but their hearing and sense of smell are very acute. By going against the wind I have got to within 10 ft. of them and seen them feeding. They do not confine themselves to worms, but will also take any kind of vegetable matter available—for example, the young shoots of a very common alpine orchid. I have found three different kinds of seed and a small white berry (of which I have not yet seen the plant) in the stomachs of those I have opened. Enclosed you will find some of the seeds on which the Kiwis subsist. I do not understand how they can find any nourishment without cracking the seeds, but the fact remains that they do, for I have found these seeds in the stomachs of several that I have opened. The grass producing this seed grows in great abundance up to a level of 2,000 ft. above the sea." The seeds sent are those of *Gahnia procera;* they are red-coloured, and of the size of small wheat.*

Apteryx oweni, Gould. (The Grey Kiwi.)

The cry of this species is very much weaker than that of *Apteryx lawryi,* described above. As with that species, however, the sexes cry together—the cry of the male resembling the shrill cry of the Woodhen, although not so loud, and that of the female being a husky screech.

* Since the above was written I have received another egg of this species from Stewart Island. It is of large size, measuring 5·25 in. in length by 3·2 in. in breadth. It is of a regular ovoido-elliptical shape, and the shell is of a clear greenish-white. It is similar to those described by me on a former occasion, and is readily distinguishable from the egg of *Apteryx mantelli.*

Art. II.—*On the Appearance of* Anosia bolina *in the Wellington District.*

By A. P. Buller.

Communicated through Sir Walter Buller, K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 22nd November, 1898.*]

It will, I am sure, be a matter of interest to entomologists to hear of the appearance of this beautiful species in the Wellington District. A fine specimen (male) was taken in the early part of May of this year close to the Papaitonga Lake (which, I may mention, is some two or three miles to the westward of the Ohau Station, on the Wellington and Manawatu line). A Maori lad noticed it on the wing, and, being struck by the unusual brilliancy and beauty of the butterfly, gave chase, and succeeded in capturing it. This piece of good luck was, no doubt, due to the fact that it was late in the autumn, and a bitterly cold south-east wind was blowing from the adjacent Tararua Mountains. This had probably a benumbing effect on the butterfly, and limited its powers of flight, for the Maori boy was able to run it down without much difficulty, and on its alighting, with wings erect, effected its capture without in any way damaging the specimen. In his anxiety that I should receive it alive, he kept it imprisoned in a small box for some days, feeding it on moist sugar and honey.

My father, on a recent trip to the Fiji Islands, captured some twenty or thirty specimens of the South Sea Island type of this butterfly, and he noticed that it was ever on the alert, and so vigorous a flier that to take it on the wing meant a long chase with the net. He observed that it particularly affected the plantations of *taro*, on the tender leaves of which the larvæ may possibly feed. As far as I am aware, this is the first record of its appearance in the Wellington District. The natives, who took a considerable interest in its capture, told me that it was the first of its kind they had seen, and they are, as a general rule, most observant in matters of natural history.

The Rev. Richard Taylor, in his book, "New Zealand and its Inhabitants" (published in 1855), speaks of "a fine large butterfly" being found in the Middle Island, closely resembling the English "Purple Emperor." In his later edition—1870—he figures it as *Diadema arge*, and characterizes it as being "the rarest and finest of our butterflies," but makes no further mention of its habitat.

It has been thought by some to be an introduction into this colony from the South Sea Islands, but I think this theory can scarcely hold good, for at the time the Rev. Mr. Taylor first makes mention of it—1855—there could have been very little, if any, communication with the Fijis.

On comparing the specimen with my Fijian series, I find that it is appreciably larger than the island form, its measurement from tip to tip being 3⅞ in. Out of twenty male specimens of the island form, the largest measures 3¼ in. and the smallest 2½ in., the rest of them giving a fairly uniform measurement of 2¾ in. to 3 in. I notice, also, that the buff-coloured bar on the under-surface of the secondary wings is considerably broader, and the small pale-blue ocellated spots on the under-surface of the primaries somewhat larger, than in its Fijian congener. I should think it is quite entitled to rank as a distinct race of the species, and to take its place accordingly in our list of *Rhopalocera*.

Since writing the above I have been fortunate enough to add two more specimens of *Anosia bolina* to my collection. They were both taken by Mr. J. B. Mackenzie, in the Nelson Province: one—a battered male—was taken on the wing, after a long chase, at Motueka, early in February of this year; and the other, a female, at Kaitiritiri, near Motueka, towards the end of April. He tells me that he found the latter fluttering feebly at the foot of a high cliff, having apparently been beaten down by the wind.

One—a male—has recently been taken at Picton by Mr. F. W. Andrews, and presented by him to the Colonial Museum. On comparing it with mine I find that it almost corresponds as to measurement, being only a shade smaller. This rather goes to show that the local capture is not of abnormal measurement, and it indicates a persistence as to size in the New Zealand form as compared with that from the South Sea Islands. I should state, however, that the male taken by Mr. Mackenzie is somewhat smaller than the Ohau and Picton examples, though noticeably larger than any in my Fijian collection. The female taken by him measures 4 in. from tip to tip, and is most vivid in colour.

Mr. G. V. Hudson tells me that solitary specimens, ranging over a period of twenty years, have been taken in Auckland, Napier, Nelson, Wakapuaka, and Collingwood, and one seen in Christchurch. So far it would appear, from recorded captures, that it principally occurs in the northern portion of the South Island, although at all times a rare butterfly.

ART. III.—*Supplement to the* Stenopelmatidæ *of New Zealand.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 3rd August, 1898.*]

Plate II. (in part).

I WISH to make the following corrections and additions to my paper on the *Stenopelmatidæ*, published in the twenty-ninth volume of the "Transactions of the Zealand Institute":—

Page 224.

There is a mistake in the synopsis of the genus *Pleioplectron*. It should read as follows, now that *P. diversum* is left out:—

"Fore femora with one and middle femora with two apical spines. Fore and middle tibiæ with two pairs of apical spines; hind tibiæ with three pairs, of which the superior is much the longer."

The words "hind tibiæ with three pairs" were, unfortunately, omitted.

Talitropsis sedilotti (page 225).

I have received a female of this species from Makaretu, in Hawke's Bay, collected by Mr. W. F. Howlett, which differs slightly from my description of those from the South Island, which was taken from males. The inferior margins of the lobes of the pronotum do not descend posteriorly, and the lobes of the meso- and meta-nota are rounded. The small spines on the upper surface of the hind tibiæ alternate with the larger ones, so that there are only two (not four) rows. The second joint of the hind tarsi is not less than half the first. Seventh abdominal segment below with two short spines. Subgenital plate notched at the end.

Colours.—Tawny, paler below, variegated with brown on the back and sides; a pale band down the centre of the pronotum; knees, tibiæ, and tarsi of the hind legs brown; ovipositor getting brown towards the apex.

Length, 18 mm.; pronotum, 5 mm.; thorax, 10 mm.; abdomen, 10 mm.; ovipositor, 12 mm.; antenna, 72 mm.; fore tibia, 8 mm.; hind tibia, 13½ mm.; hind femur, 13½ mm. Width of mesonotum, 5½ mm.

The following is a key to the species:—

Spines on the hind tibiæ of two sizes	*T sedilotti.*
Spines on the hind tibiæ of one size.	
Spines, 8 or 9	*T. crassicruris.*
Spines, 13	*T. irregularis.*

Pachyrhamma novæ-seelandiæ (page 232).

Brunner's figure shows spines on the middle femora, although no mention is made of them in the text.

Pachyrhamma fascifer (page 232).

In the third line of the description, for "fore tibiæ" read "middle tibiæ."

Pleioplectron diversum (page 235).

I have received from Mr. W. F. Howlett, of Makaretu, Hawke's Bay, a male specimen of this species, which shows that it cannot be kept in *Pleioplectron*, as the supra-anal and subgenital plates are very different, but must be placed in a new genus, for which I propose the name "*Miotopus*."

MIOTOPUS, gen. nov.

Fore and middle femora with two short apical spines, those on the middle femora longer. Middle tibiæ armed with spines on the upper surface. Supra-anal plate of the male transverse, the apex truncated and without any point; the cerci rather long and slender. Subgenital plate of the male longer than broad, rounded at the apex, the styles very short and situated near the apex. The rest as in *Pleioplectron.*

Miotopus diversus. Plate II., figs. 1*a*, 1*b*.

Pleioplectron diversum, Hutton, Trans. N.Z. Inst., vol. xxix., p. 235.

Male.—The antennæ are thicker than in the female. The middle tibiæ have two or three spines on the upper surface. Length, 20 mm.; of pronotum, 5 mm.; of thorax, 9 mm.; of abdomen, 10 mm.; of fore tibia, 10 mm.; of hind tibia, 18 mm.; of hind femur, 16 mm. Width of mesonotum, 5 mm.

Locality.—Makaretu, Hawke's Bay (W. F. Howlett).

Macropathus edwardsii (page 240).

Mr. Scudder has kindly re-examined the type of this species for me, and finds that it does not agree with Brunner's description of what he thought to be *H. edwardsii*, nor does it belong to *Macropathus*, as I supposed it might do, but to *Pleioplectron*. He informs me that "the fore femora have an apical spine on the outer side only, the middle femora on both sides, and the

hind femora have none. The fore and middle tibiæ have a pair of apical spines on each side, the lower of which are longer, but not to a great degree. The spines on the upper surface of the hind tibiæ are of two grades, and more or less irregular. The longest spurs at the end of the hind tibiæ are the middle pair. The apical spines of the femora are testaceous, deepening apically in colour to reddish-fuscous, and are about half as long as the width of the genicular lobes from which they spring."

The following is a key to the species of *Pleioplectron* :—

Hind femora with two minute spines below; hind tibiæ less than five times the length of the pronotum.
- Hind tibiæ less than three times the length of the pronotum.
  - Proximal joints of the antennæ rather broader than long .. .. *P. simplex.*
  - Proximal joints of the antennæ much broader than long .. .. *P. pectinatum.*
- Hind tibiæ more than three times the length of the pronotum .. .. *P. hudsoni.*

Hind femora unarmed below; hind tibiæ more than six times the length of the pronotum .. .. *P. edwardsii.*

It is remarkable that our cave-wetas should belong to three different endemic genera—omitting the doubtful *Hemideina abbreviata.* Cave-wetas belonging to other genera are known in North America, Europe, and Burmah, and all, as well as our own, belong to the *Dolichopodinæ,* distinguished by having no foot-pads. In our genera, *Macropathus* is closely allied to *Pharmacus,* which lives on the mountains, both being known at present only from the South Island; *Pachyrhamma* is allied to *Gymnoplectron,* which lives among the branches of trees, both genera being known at present only from the North Island; *Pleioplectron* has, in the South Island, one cave species and two which live among rotten wood, and one outdoor species in the North Island. Now, we cannot suppose that the immediate ancestors of our cave-wetas lived in caves during their migration into New Zealand, partly because of the physical impossibility of their having passed from one cave to another, and partly because each is closely allied to other species which do not live in caves. *Macropathus* and *Pleioplectron* may have originated from a common ancestor in New Zealand; but *Pachyrhamma* is more nearly related to European and American forms, and its original ancestors in New Zealand must have been distinct from those of *Pleioplectron.* We must therefore, I think, conclude that our first immigrant *Dolichopodinæ* did not live in caves, but that some of their descendants have, like their remote northern ancestors, taken to that curious mode of life. If this be true, we have here a most remarkable example of the resuscitation

of a habit which must have remained dormant or latent through many generations. It is well known that physical characters may remain latent for an unknown number of generations, but this is, I believe, the most remarkable case yet recorded of latent psychological characters.

CORRECTIONS IN THE PLATES (page 241).

PLATE XII.

Fig. 4*b*. The sounding-organs are not shown in the figure.
Fig. 5*b*. Should be "*Onosandrus focalis*, side view, showing sounding-organs."
Fig. 5*c*. Should be omitted.
Fig. 5*d*. Should be "*Onosandrus focalis*, sternum."

PLATE XIII.

Fig. 13*a*. Should end in a point, not in a slit. The slit was intended to represent a keel.
Fig. 15. Should be "*Pleioplectron hudsoni*, supra-anal plate of male."

Mr. W. F. Kirby, of the British Museum, has kindly looked over Walker's types, and sends me the following notes:—

Deinacrida heteracantha, White.—Perhaps distinct from *D. gigantea*.

Hemideina thoracica, White.—The type has distictly four spines in each row of the hind tibiæ. *H. capitolina*, *H. figurata*, *H. producta*, *H. abbreviata*, and *H. tibialis* all appear to belong to *H. thoracica*.

Hemideina armiger, Colenso.—The same as *D. thoracica*, of Brunner.

Onosandrus lanceolatus, Walker (*Ceuthophilus*).—Appears to be a dark uniformly coloured specimen of *O. pallitarsis*.

Pachyrhamma fascifer, Walker.—This appears to be *P. speluncæ*.

Pachyrhamma altus, Walker.—Seems to agree with *P. novæ-zealandiæ*.

Macropathus species, from Auckland.—Larger than *M. filifer*, and with much more numerous and conspicuous teeth on the hind femora beneath.

Art. IV.—*Notes on the New Zealand* Acrididæ.

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate II. (in part).

This paper contains descriptions of new species of alpine grasshoppers given me by Messrs. L. and A. Cockayne, as well as further details of species which have been already described; and I have arranged the genera into two groups, after the classification of C. Brunner de Wattenwyl in his "Révision du Système des Orthoptères."

An examination of a European specimen of *Podisma* (= *Pezotettix*) *alpina* and an American one of *Bradypus obesa*, kindly sent by Mr. S. H. Scudder, has shown me that our species cannot be placed in either of those genera, and I propose for them a new genus, called "*Brachaspis*," from its short and broad sternal shield.

Artificial Key to the Genera.

a. Pronotum flattened above, the lateral keels distinct.
- a^1. Hind femora without an apical tooth.
  - a^2. Antennæ three-quarters the length of hind femur .. .. .. *Sigaus*.
  - b^2. Antennæ one-half the length of hind femur .. .. *Trigoniza*.
- b^1. Hind femora with a minute apical tooth.
  - c^2. Tegmina touching each other .. .. *Phaulacridium*.
  - d^2. Tegmina widely separated .. .. *Paprides*.

b. Pronotum rounded above, without any lateral keels .. *Brachaspis*.

Family ACRIDIDÆ.

Group MESEMBRIÆ, Brunner.

Fastigium divided from the frontal costa by a transverse carina,* its longitudinal keel very slight or absent. Frontal costa straight or slightly sinuated. Antennæ longer than the fore femora. Pronotum nearly flat, smooth or granulated, three-keeled in all the New Zealand species. Hind tibiæ rounded on the sides, armed with more than seven spines (eight to ten in the New Zealand species), regularly disposed on the outer margin, the spine immediately behind the apical spine absent on the outer side. Second joint of the hind tarsi half the length of the first.

Confined to the Old World.

* Except in some species of *Paprides*.

Genus SIGAUS.

This genus resembles the African *Apoboleus* in that the frontal costa dies away a little below the eyes, as well as in the rounded prosternal tubercle. From *Tritropis*, of Australia, it differs in having only lobiform tegmina, as in *Mesambria*, from which it differs in the frontal costa not being produced nor sinuated.

Sigaus piliferus.

Subgenital plate of the female elongated, the apex with a truncated point and a shoulder on each side.

Genus TRIGONIZA.

Subgenital plate of the female with a long acute point, springing from the lower surface a little behind the apex, which is hidden between the bases of the lower pair of the ovipositor.

Trigoniza directa. Plate II., figs. 8*a*–8*c*.

Apex of the subgenital plate in the female with two sharp teeth. Subgenital plate in the male broader than the abdomen, much recurved, rounded at the apex. The supra-anal plate triangular, apex acute, cerci long, projecting far in front of the apex. Furcula of the tenth segment well developed.

Trigoniza campestris. Plate II., fig. 9.

Subgenital plate of the female with the apex truncated, rugulose, but without any well-marked teeth.

I have received a specimen from Mount Cook Hermitage (collector, H. Suter).

Trigoniza rugosa. Plate II., fig. 10.

Subgenital plate of the female with the apex rounded and smooth.

Genus .PHAULACRIDIUM.

Probably I was wrong in giving *Praxilla*, of Stål, as a synonym of this genus, as *Praxilla* is said to have the distal spine on the outer margin of the hind tibiæ developed, and therefore to belong to another group. If this is the case, *Praxilla* does not occur in New Zealand.

Phaulacridium marginale. Plate II., figs. 2*a*–2*c*.

Subgenital plate of the female acuminate, the apex ending in a sharp tooth with a smaller cusp on each side; supra-anal plate triangular. In the male the subgenital plate is not broader than the abdomen, and is recurved, the recurved portion with a concave sinuation, the apex rounded; supra-anal plate acuminate; 'cerci short, not projecting beyond the apex

of the supra-anal plate. Furcula of the tenth segment well developed.

I have received a specimen from the Great Barrier Island. In Canterbury it is found from sea-level to about 2,000 ft. or 3,000 ft. above the sea. On Mount Torlesse Mr. Cockayne has obtained a variety which is olive-green above and yellow-green below. It was found in company with typical specimens.

Genus PAPRIDES.

The subgenital plate in the female has a long subapical point, which is hidden between the bases of the lower division of the ovipositor, as in *Trigoniza*. The genus is closely related to *Phaulacridium*, but differs in having the frontal costa sulcate, the antennæ thicker and with 23 or 24 joints, as well as in other points. In *P. australis*, *P. furcifer*, and *P. nitidus* the margins of the fastigium meet in front and separate it from the frontal costa; but in *P. torquatus* and *P. armillatus* this is not the case, and the fastigium passes into the frontal costa, as in the *Melanopli*.

ARTIFICIAL KEY TO THE SPECIES.

Anterior margin of the lobes of the pronotum yellow.
- Brownish-olive; subgenital plate of ♀ two-toothed — *P. torquatus.*
- Green; subgenital plate of ♀ three-toothed .. *P. armillatus.*

Anterior margin of the lobes of the pronotum not yellow.
- Vertex deflexed; prosternal tubercle truncate.
  - Subgenital plate of ♀ three-toothed — *P. nitidus.*
  - Subgenital plate of ♀ two-toothed — *P. furcifer.*
- Vertex hardly deflexed; prosternal tubercle rounded.
  - Subgenital plate of ♀ three-toothed — *P. australis.*

Paprides australis. Plate II., fig. 5.

Apex of the subgenital plate of the female pointed, and with a small tooth at each side.

Paprides nitidus. Plate II., fig. 4.

Apex of the subgenital plate of the female truncated, with three subequal teeth.

Paprides furcifer, sp. nov. Plate II., figs. 3*a*–3*c*.

Above green, either bright or dull, with pale-purplish lateral stripes from the vertex to the tegmina, and on the upper surfaces of the hind femora; also along each side of the abdomen. Sides of the abdomen, below the pale band, fuscous. Lower surface, both the sternum and the abdomen, greenish-yellow. Hind tibiæ uniform yellowish-orange. Apex of the subgenital plate in the female notched in the middle, thus forming two blunt teeth. Subgenital plate in the male not broader than the abdomen, the apex rather acute, the lateral margins with a single sinuation. Supra-anal plate in the male with the

apex rounded, and notched on each side; cerci short, not projecting beyond the apex of the plate. Furcula of the tenth segment not well marked.

Length, ♂ 18 mm., ♀ 26 mm.; of pronotum, ♂ 4½ mm., ♀ 6 mm.; of hind femur, ♂ 11 mm., ♀ 14½ mm.

Locality.—Mount Torlesse (A. Cockayne), and Hill's Peak, near Arthur's Pass (L. Cockayne). 3,000 ft. to 4,200 ft.

This species closely resembles *P. nitidus*, but differs from it in the shape of the subgenital plate of the female, and the frontal costa does not project so much in front of the antennæ. Mr. L. Cockayne informs me that it is sometimes semi-aquatic in habit. He saw numbers round a tarn on Hill's Peak, either basking on *Donatia* at the margin, or on the water itself. They swim on the surface with great rapidity, using their hind legs.

Paprides torquatus, sp. nov. Plate II., fig. 6.

Vertex slightly rugulose, without any median keel, much deflexed in front, and passing into the frontal costa, the margins of the fastigium not meeting. Frontal costa produced in front of the base of the antennæ to a distance about equal to the breadth of the eye. Antennæ in the male slightly clavate. Anterior sulcus of the pronotum not extending completely across the disc. Prosternal tubercle rounded at the apex. Subgenital plate of the female notched at the apex, thus forming two blunt teeth; supra-anal plate broad, rounded at the apex. Subgenital plate in the male with the apex rounded, the lateral margins not sinuated. Supra-anal plate in the male triangular, the apex acute. Furcula of the tenth segment obsolete.

Colours. — Brownish-olive, marked with black. The anterior margin of the pronotum on each side with a narrow yellow band, immediately behind which is a broad black mark; disc of the pronotum and vertex purplish-brown. A lateral stripe on each of the tegmina brownish-yellow. Hind femora with three dark transverse bands, their under-surfaces rosy-red. Hind tibiæ rosy-red, with a broad yellow transverse band near the proximal end, which is margined on each side with black. Spines black. These colours are from fresh specimens.

Length, ♂ 18 mm., ♀ 29 mm.; of pronotum, ♂ 4 mm., ♀ 7 mm.; of hind femur, ♂ 12 mm., ♀ 18 mm.

Locality.—Mount Torlesse, Canterbury, at elevations of about 4,000 ft.; among *Dracophyllum* (A. Cockayne).

Paprides armillatus, sp. nov. Plate II., fig. 7.

Like *P. torquatus*, but the anterior transverse suture of the pronotum is obliterated. The prosternal tubercle trun-

cate at the apex. The subgenital plate in the female has the apex notched on each side, thus forming three blunt teeth; supra-anal plate rounded at the apex. Male not known.

Colours.—Bright-green above; the anterior margin of the pronotum yellow on the sides. Tegmina yellowish-brown. Lower surface pinkish. Hind femora with three dark transverse bands, their lower surfaces orange-red. Hind tibiæ orange-red, with a broad band of yellow, margined on each side with black, near the proximal end; the spines black.

Length, ♀ 31 mm.; of pronotum, ♀ 6 mm.; of hind femur, ♀ 18 mm.

Locality.—Mount Torlesse, Canterbury, at elevations of about 3,000 ft. (A. Cockayne).

Group MELANOPLI, Scudder.

Pezotettiges, Brunner.

Closely allied to the *Mesembriæ*, but the fastigium is always deflexed, and passes insensibly into the frontal costa, there being no dividing-ridge between the two. Also the pronotum is not flat, but rounded, and lateral carinæ are rarely present. In the species of the Northern Hemisphere the spines in the outer row on the hind tibiæ are 9 to 14 (very rarely 8), while in the New Zealand forms the number of spines is from 6 to 8.

Chiefly American, but a few species are found in Europe, and one in Africa.

Genus Brachaspis, gen. nov.

Pezotettix, Hutton, Trans. N.Z. Inst., vol. xxx., p. 143, not of Burmeister.

As the characters I gave in my former paper were taken from New Zealand insects they will serve for those of *Brachaspis*, but I will add a few others.

The antennæ in the female are about as long as the fore femora, longer in the male. The tegmina are never absent, but rarely project beyond the first abdominal segment. The tympana are distinct, but hidden by the points of the tegmina. The subgenital plate in the female has a long subapical point, which is hidden between the bases of the lower division of the ovipositor. The supra-anal plate in the male and the sternal shield in both sexes are variable—by the sternal shield I mean the fused sterna of the mesothorax, the metathorax, and the first abdominal segment. In all the species it is either as broad as or broader than long, in which the genus resembles *Bradyotes* more than *Podisma* (= *Pezotettix*). But from *Podisma* it is distinguished by the pronotum being without any trace of a keel and emarginate behind, as well as by the strong prosternal tubercle, which is transverse and truncated; also,

the metasternal lobes are much closer together in the female. The ovipositor is exserted, and the frontal costa is narrower above the antennæ and more projecting than in *Podisma*.

The species are closely related to each other. All have the same habit of living among stones in river-beds or shingle-slips, but they have different localities. The colours also are much the same, and the distinguishing marks of the species must be looked for in the sternal shield and the subgenital plate of the female.

Brachaspis petricolus. Plate II., figs. 13*a*, 13*b*.

Specimens from the bed of the Kowai River are slate-coloured, and the hind tibiæ are not so bright as in *B. nivalis*. The interspace between the mesosternal lobes in the female is rather wider than the lobes, and in the male it is about equal to the lobes. In the metasternum the interspace in the female is more than half the width of the interspace between the mesosternal lobes; in the male the metasternal lobes are subcontinuous. The subgenital plate in the female has two small rounded cusps, one on each side of the apex. The hind tibiæ have seven or eight spines in the outer row.

Length of the hind femur, ♂ 8½–9 mm., ♀ 11½–13½ mm.

Brachaspis nivalis. Plate II., figs. 11*a*–11*c*.

Specimens from the shingle-slips of Mount Torlesse, from 3,000 ft. to 5,500 ft. above the sea. Collected by L. Cockayne.

The interspace between the mesosternal lobes in both male and female is about as wide as the lobes. The interspace between the metasternal lobes in the female is about half the width of the interspace between the mesosternal lobes, while in the male the metasternal lobes are subcontinuous. The subgenital plate in the female has two small but sharp cusps, one on each side of the apex. Occasionally the hind tibiæ have only six spines in the outer row.

Length of the hind femur, ♂ 11½–12½ mm., ♀ 14½–17 mm.

There are two varieties :—

α. Greyish-brown or slate-blue, with the hind tibiæ and lower surfaces of the hind femora blue or sometimes red.

β. Ochreous-brown or stone-colour, with the hind tibiæ and lower surfaces of the hind femora rosy-red.

Brachaspis collinus. Plate II., fig. 12.

The interspace between the mesosternal lobes, in both male and female, is less than the width of the lobes. The interspace between the metasternal lobes in the female is more than half that of the interspace between the mesosternal lobes, and in the male it is about half the width of that space. The subgenital plate in the female has two strong and sharp

cusps at the apex, one on each side. The metanotum and the first abdominal segment are roughened; not the first three abdominal segments, as stated in my former paper.

Brachaspis terrestris. Plate II., fig. 14.

The centre of the sternal shield in my only specimen has been destroyed by the pin, so that I cannot give a description of it. The subgenital plate in the female is rounded at the apex. The hind tibiæ have eight spines in the outer row.

EXPLANATION OF PLATE II.

Fig. 1*a*. *Miotopus diversus*, supra-anal plate of male.
Fig. 1*b*. „ subgenital plate of male.
Fig. 2*a*. *Phaulacridium marginale*, end of abdomen of male from above.
Fig. 2*b*. „ end of abdomen of male from the side.
Fig. 2*c*. „ subgenital plate of female.
Fig. 3*a*. *Paprides furcifer*, end of abdomen of male from above.
Fig. 3*b*. „ end of abdomen of male from the side.
Fig. 3*c*. „ subgenital plate of female.
Fig. 4. *Paprides nitidus*, subgenital plate of female.
Fig. 5. *Paprides australis*, subgenital plate of female.
Fig. 6. *Paprides torquatus*, subgenital plate of female.
Fig. 7. *Paprides armillatus*, subgenital plate of female.
Fig. 8*a*. *Trigoniza directa*, end of abdomen of male from above.
Fig. 8*b*. „ end of abdomen of male from the side.
Fig. 8*c*. „ subgenital plate of female.
Fig. 9. *Trigoniza campestris*, subgenital plate of female.
Fig. 10. *Trigoniza rugosa*, subgenital plate of female.
Fig. 11*a*. *Brachaspis nivalis*, end of abdomen of male from above.
Fig. 11*b*. „ end of abdomen of male from the side.
Fig. 11*c*. „ subgenital plate of female.
Fig. 12. *Brachaspis collinus*, subgenital plate of female.
Fig. 13*a*. *Brachaspis petricolus*, subgenital plate of female.
Fig. 13*b*. „ sternal shield of female.
Fig. 14. *Brachaspis terrestris*, subgenital plate of female.

Art. V.—*Revision of the New Zealand* Phasmidæ.

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Last year when I read my paper on the *Phasmidæ* of New Zealand* I never thought that I should so soon be in a position to correct the nomenclature of the species; but last August

* Trans. N.Z. Inst., xxx., art. xx.

Mr. H. Suter submitted to me for examination a large collection of these insects which he had obtained from the Great Barrier Island, and he has very kindly given to the Canterbury Museum a complete set of the species it contained. This collection, coming from the north, from whence all the earlier-described species came, has enabled me to identify all but one of the species described by Mr. Westwood, and all but two of those described by the Rev. W. Colenso; and I am therefore, thanks to the aid of Mr. Suter, in a position to make what I believe to be an accurate list of the known species.

I find that, having had southern specimens only to examine, I made some wrong identifications in my last paper. I therefore now withdraw all the localities given in it, and substitute those in the present paper.

I feel rather doubtful about reintroducing the genus *Acanthoderus*, of Gray, as it is not defined either by Stål or by Brunner. Gray's type—*A. spinosus*, from Western Australia—was in the Hope collection, and may have been seen by Westwood, who placed *A. spiniger* and *A. horridus* next to it, followed by *A. prasinus*. But the generic characters say that the mesothorax is nearly as long as the metathorax, which is not the case in *A. horridus* (= *A. spiniger*), but is true for *A. prasinus*. I therefore suppose that *A. prasinus* is congeneric with *A. spinosus*, but the point can only be settled by a comparison of the two species. The *Acanthoderus* of Stål, in his "Recensio Orthopterorum" (p. 49)—given as *Acanthoderus* (Westw.)—is, as he says, very different, and belongs to a different family. But Stål had no right thus to shift Gray's name.

As references to descriptions and figures of the species are given in my last paper, I have not thought it necessary to repeat them here.

All the New Zealand *Phasmidæ* belong to the tribe *Clitumnides*, as defined by Brunner de Wattenwyl in his "Révision du Système des Orthoptères," 1892. The antennæ in the young are proportionately shorter in this tribe than in the adult, but they have the full number of joints.

Tribe CLITUMNIDES, Brunner (1892).

Antennæ shorter (or not much longer) than the anterior femora, the joints distinct and not more than 28. Median segment of the metanotum short. Apterous. Tibiæ carinated below to the apex, and without any apical areola.

In all the New Zealand species the suture between the median segment and the metanotum proper is obliterated, but its position is generally marked by a spine, or a pair of spines; or, in *Clitarchus*, by a black spot.

Genus Pachymorpha, Gray (1835).

In the New Zealand species the number of joints in the antennæ is from 16 to 20. The first abdominal segment is subquadrate, and the first joint of the anterior tarsi is twice as long as the second. In *P. hystriculea* the anal segment of the female (judging from the figure) is long and compressed, completely hiding the styles, as in *P. squalida;* but in the three species described by me it is expanded and rounded at the end, while the styles are exposed. They thus approach more nearly those species which Brunner has put into his genus (or subgenus) *Parapachymorpha*, but they do not quite come within any of his sections.

Artificial Key to the Species.

Thorax with spines.
- Two spines on the middle of the mesothorax .. *P. hystriculea.*
- No spines on the middle of the mesothorax .. *P. annulata.*

Thorax without spines.
- Two tubercles between the eyes .. .. .. *P. salebrosa.*
- No tubercles between the eyes .. .. .. *P. acornuta.*

Pachymorpha hystriculea, Westwood (1859).

The antennæ are 16-jointed. The mesothorax has two spines near its anterior extremity, two near the middle, and two near the hind margin, and the hinder extremity is armed with several smaller spines. The metathorax has a pair of spines near its fore end, and its extremity is dilated and armed with several divergent spines. The six basal segments of the abdomen are armed with a spine on each side near the base, the fourth segment being furnished with a dorsal and two lateral foliaceous appendages. The terminal segments of the abdomen are narrower than the others. The ovipositor is emarginate at the tip, and does not reach to the apex of the ninth segment. (Westwood.)

This species is not represented in the Museum collection.

Pachymorpha salebrosa, sp, nov.

P. hystriculea, Hutton, Trans. N.Z. Inst., vol. xxx., p. 162, not of Westwood.

Female.—Colour almost uniformly brown when dry. Antennæ 20-jointed. Head with two black tubercles between the eyes, united at their bases. Thorax and abdomen very rough with short points, but no spines, except a row of short ones on the meta-episterna, and a distant pair at the posterior margins of the mesonotum, metanotum (proper), median segment, and the first five abdominal segments. The third and fourth abdominal segments with dorsal and lateral foliaceous appendages, those on the third smaller. First abdominal segment rather longer than broad. Anal segment rather

longer than broad, rounded at the apex. Cerci exposed. Ovipositor large, rounded at the apex, not reaching much beyond the end of the eighth segment. Fore femora with a few denticulations both above and below. Middle femora with two or three strong teeth in each row above and two in each row below. Hind femora with four or five strong teeth in each row above and two small ones below. All the tibiæ denticulated.

Length of the body, 54 mm.; of mesonotum, 11 mm.; of metanotum, 9 mm.; of the abdomen, 29 mm.; of the antennæ, 9 mm.; of the fore femora, 13 mm.; of the mid femora, 11 mm.; of the hind femora, 14 mm.

Male unknown.

Hab. Dunedin.

Pachymorpha annulata, Hutton (1898).

The antennæ have 17 joints, the base of the seventh and the whole of the seventeenth pale. The first abdominal segment is rather broader than long. The anal segment is rather longer than broad, rounded and slightly emarginate at the apex. The cerci are exposed. Ovipositor extending about two-thirds the length of the ninth segment.

Male unknown.

Hab. Dunedin.

Pachymorpha acornuta, sp. nov.

Female.—Body subtectiform, a keel running down the back. Yellowish-grey mottled with darker, a transverse fuscous mark on the head between the eyes, and a single fuscous spot on the posterior margins of the pronotum and mesonotum. Bases of the middle and hind femora paler and yellowish. Head with a low transverse ridge between the eyes, not divided. Antennæ 16-jointed, the tips of the last joint fuscous. Basal joint of antennæ, head, and pronotum more rugose than the rest of the body, but without any trace of spines, except a short one at the posterior end of the mesonotum. Metanotum with two short spines, one behind the other, near the posterior end. The first seven abdominal segments each with a single short spine near the posterior margin, and a few low tubercles on each side of it. No foliaceous appendages. A row of small tubercles on the episterna of the meso- and meta-thorax. Sterna with a few low tubercles, those of the abdomen with a pair near the posterior margin of each segment. First abdominal segment broader than long. Anal segment as broad as long, rounded and slightly emarginate at the apex. Cerci exposed. Ovipositor slightly keeled, reaching the end of the ninth segment; the apex acute. All the femora and tibiæ with blunt denticu-

lations above, and the femora of the middle and hind legs have three very small ones below, in a row.

Length of the body, 43 mm.; of mesothorax, 9 mm.; of metathorax, 6 mm.; of abdomen, 22½ mm.; of antennæ, 7 mm.; of fore femur, 11 mm.; of mid femur, 8 mm.; of hind femur, 10 mm.

Male unknown.

Hab. Great Barrier Island.

An immature specimen, probably belonging to this species, is much smoother, and the fourth abdominal segment has a slight dorsal expansion. The fore femora are almost smooth, and the denticulations of the middle and hind femora are very small.

This species is easily distinguished from any of the others by the absence of the two tubercles on the head, by the spines on the abdomen being single instead of in pairs, and by the absence of lateral expansions on the abdomen.

Genus Clitarchus, Stål (1875).

Clitarchus, Section A, Hutton, Trans. N.Z. Inst., vol. xxx., p. 162.

The first abdominal segment is much longer than the median segment of the metanotum. In the male the last abdominal segment is inflated, and the anal styles are fully exposed.

Artificial Key to the Species.

Fore femora with 5 or 6 strong teeth.	
Middle femora with two denticulations on inferior ridge.	
Posterior femora with two denticulations on inferior ridge	*C. hookeri.*
Posterior femora with one or no denticulations on inferior ridge	*C. coloreus.*
Middle and posterior femora without any denticulations on inferior ridge	*C. reductus.*
Fore femora smooth, or with a few slight denticulations	*C. læviusculus.*

Clitarchus hookeri, White (1846).

The *female* is subrugose, the head and thorax distantly granulated, the granules on the vertex generally arranged in a V. The bases of the fore femora are rosy. The antennæ are pale, each joint with a black spot at the distal end; they are 21-jointed. Length of the body, 91 mm.; of mesothorax, 18 mm.; of metathorax, 16½ mm.; of abdomen, 46 mm.; of antennæ, 22 mm.; of anterior femur, 22 mm.; of middle femur, 15 mm.; of posterior femur, 19 mm.

The *male* has a few—up to six—granules on the mesonotum arranged in two rows; and the fore femora have five teeth, the middle and posterior femora have two small denti-

culations (in addition to the distal pair) on the inferior ridge. There is sometimes a dark lateral stripe on the head and thorax, and a black spot on the centre of the posterior margin of each abdominal segment. Length of the body, 64 mm.; of mesothorax, 15 mm.; of metathorax, 13 mm.; of abdomen, 32 mm.; of antennæ, 25 mm.; of anterior femur, 19½ mm.; of middle femur, 14 mm.; of posterior femur, 16 mm.

Hab. Great Barrier Island and northern parts of New Zealand, where it is common, the males nearly as abundant as the females.

Clitarchus coloreus, Colenso (1885).

In this species the head and thorax are nearly smooth, and the colour is lighter—in North Island specimens—than in *C. hookeri*, but it is probably only a variety of that species. The antennæ are from 22- to 24-jointed.

In the *female* the fore femora have five teeth, the middle femora have two small denticulations on the inferior ridge, and the posterior femora have the inferior ridge either smooth or with a single denticulation. Length of the body, 86 mm.; of mesothorax, 17½ mm.; of metathorax, 15 mm.; of abdomen, 43 mm.; of antennæ, 22 mm.; of anterior femur, 21½ mm.; of middle femur, 15 mm.; of posterior femur, 19 mm.

In the *male* the fore femora are smooth or slightly denticulated. The colours are the same as in the female, but usually there is a dark lateral band on each side, more strongly marked on the head and thorax than on the abdomen. Also the anterior margins of the abdominal segments often have a small black spot on each side of the median dark line. Length of the body, 58 mm.; of mesothorax, 10½ mm.; of metathorax, 11 mm.; of abdomen, 31 mm.; of antennæ, 24 mm.; of anterior femur, 16 mm.; of middle femur, 13 mm.; of posterior femur, 15 mm.

Hab. Great Barrier Island (abundant, both males and females); Hawke's Bay; Canterbury.

Mr. Colenso describes the eggs as being laid in June. The single specimen I have from Canterbury is of a dark-brown colour (dry), and looks very different from those from the Great Barrier.

Clitarchus reductus, sp. nov.

Female.—Pale-green, with a narrow black median line on the prothorax and a black median spot at the posterior margin of the mesothorax, metathorax, and first abdominal segment; bases of the anterior femora pink. Head smooth, with six or eight rounded tubercles; thorax smooth, with a few scattered granules on the mesonotum. Antennæ 21-jointed. Fore femora with six strong teeth, the inferior

ridge of the middle and posterior femora quite smooth. Sometimes there is a slight denticulation on the outer (anterior) ridge of the posterior femora near the base. Both middle and posterior femora with a pair of strong subapical teeth as well as the apical pair.

Length of the body, 92 mm.; of mesothorax, 18 mm.; of metathorax, 16 mm.; of abdomen, 49 mm.; of antennæ, 21 mm.; of anterior femur, 25 mm.; of middle femur, 17 mm.; of posterior femur, 19 mm.

The male is unknown.

Hab. Canterbury.

Formerly this species used to be common in the neighbourhood of Christchurch.

Clitarchus læviusculus, Stål (1875).

Smooth, and with only a few or no denticulations on the anterior femora.

Hab. Great Barrier Island, not common; Canterbury.

Genus Acanthoderus, Gray (1835).

Clitarchus, Section B, Hutton, Trans. N.Z. Inst., vol. xxx., p. 164.

The first abdominal segment is rather longer than the median segment of the metanotum.

Artificial Key to the Species.

Second and following abdominal segments without spines..	*A. prasinus.*
Second and following abdominal segments with spines.	
Femora not foliated	*A. suteri.*
Femora distinctly foliated.	
Colour green	*A. geisovii.*
Colour grey, variegated dark and light	*A. fasciatus.*

Acanthoderus prasinus, Westwood (1859).

Bacillus atro-articulus, Colenso (1885).

Only the female is known. Antennæ with 23 joints. Length of the body, 94 mm.; of mesothorax, 17 mm.; of metathorax, 16½ mm.; of abdomen, 51 mm.; of antennæ, 19 mm.; of anterior femur, 24 mm.; of middle femur, 15½ mm.; of posterior femur, 19½ mm.

Hab. Great Barrier Island, a few specimens; Hawke's Bay; Canterbury.

Acanthoderus suteri, nov. nom.

Clitarchus geisovii, ♀, Hutton, Trans. N.Z. Inst., vol. xxx., p. 165, not of Kaup.

In this species the spines on the thorax are slender and pointed, as in *A. prasinus*, and differ much from those of

A. geisovii. The antennæ are broken, so that I cannot give the number of joints.

The male is unknown.

Hab. Marton, near Wanganui.

I name this species after my friend Mr. H. Suter, who has done so much good work in the investigation of the New Zealand Mollusca, and without whose help I should not have been able to identify the true *A. geisovii*.

Acanthoderus geisovii, Kaup (1866).

Female.—Pale-green, with a black spot on the base of the head, and others on the anterior and posterior margins of the pronotum, as well as on the posterior margins of the meso- and meta-nota, and each of the abdominal segments; also black spines on the head, thorax, and abdomen. Distal ends of the tibiæ and joints of the tarsi dark. Antennæ with 20 joints. Head with about nine spines, of which a central pair are larger than the others. Pronotum with two longer pairs near the posterior end. Mesonotum with about fourteen spines, a pair at the posterior margin, the rest irregular. Metanotum with about twenty spines, of which there are two pairs, one on the median suture, the other at the posterior margin, the rest more or less irregular. All the spines are very robust, and the larger ones sometimes have their bases pale. The episterna of the mesothorax have four to seven sharp spines, those of the metathorax have five or six. The epimera have two, or one, or none. The mesosternum has three or four pairs, and the metasternum five irregular small spines. Each segment of the abdomen is swollen posteriorly, and has a posterior pair of blunt black tubercles. The first, second, and third have also a few rudimentary spines. From the second to the sixth lateral foliations are more or less developed. There are no spines on the abdominal sterna, except the one at the base of the ovipositor. The anal segment is truncated at the end; the cerci, or anal styles, are broad. The ovipositor is rounded at the tip, and does not project quite to the end of the ninth segment. The anterior coxæ have two pairs of spines. The anterior femora have three or four sharp teeth on the lower outer margin, and some smaller ones on the upper. The middle and posterior femora have three teeth on each of the upper and lower ridges. All the femora are distinctly foliated. The middle and posterior tibiæ have a blunt tooth above, near the proximal end. The abdomen is narrow. Length of the body, 74 mm.; of meso-thorax, 13 mm.; of metathorax, 13 mm.; of abdomen, 40 mm.; of antennæ, 19 mm.; of anterior femur, 20 mm.; of middle femur, 13½ mm.; of posterior femur, 16 mm.

Male.—"The ten black spines of the head are placed in three rows. On the end of the prothorax, in the middle, a black spot; and a fine line along the middle of the mesothorax. Some of the irregularly formed and placed spines are black at the ends. The tubercles of the metathorax obtuse and unicolour. The leaves look short; anal styles on both sides in the middle carinated" (Kaup). Length of the body, 39 mm.; of mesothorax, 7½ mm.; of metathorax, 8½ mm.; of abdomen, 23 mm.; of antennæ, 8 mm.

Hab. Great Barrier Island, several females; Canterbury, one female.

Acanthoderus fasciatus, sp. nov.

Pale-grey, variegated with darker. Femora and tibiæ with transverse dark bands. Posterior end of each abdominal segment dark. Antennæ 20-jointed. Head with about ten spines, one pair larger than the others. Pronotum with two pairs of spines near the posterior margin, the anterior pair much smaller. Mesonotum with about thirty-four thick spines placed irregularly, except the posterior pair. Metanotum with about twenty-four thick spines. Episterna of the meso- and meta-thorax with a row of seven spines. Eight small spines on the mesosternum and six on the metasternum. Abdomen as in *A. geisovii*, the fourth, fifth, and sixth segments with lateral expansions. Anal segment squarely truncated at the end. Ovipositor not reaching to the end of the eighth segment. Femora foliaceous; the anterior with five teeth above and seven on the outer lower margin. Middle and posterior femora with four strong teeth on each of the four ridges. Middle and posterior tibiæ with a strong tooth on the upper side, near the proximal end.

Length of the body, 54 mm.; of mesothorax, 10 mm.; of metathorax, 9½ mm.; of abdomen, 30 mm.; of antennæ, 9 mm.; of anterior femur, 14 mm.; of middle femur, 10 mm.; of posterior femur, 10½ mm.

Hab. Great Barrier Island. A single specimen.

This species is allied to *A. geisovii*, but is distinguished from it not only by its colours, but by the more numerous spines on the thorax, and the stronger teeth on the legs.

Genus Argosarchus, Hutton (1898).

The first abdominal segment is considerably longer than broad, nearly twice as long as the median segment of the metanotum. The suture between the median segment and the rest of the metanotum is not marked by spines, as it is in *Acanthoderus*. In the male the basal joints of the tarsi are not crested.

Argosarchus horridus, White (1846).

A. spiniger, White, ♂; *B. filiformis*, Colenso, ♂; *B. gerhardii*, Kaup, ♀.

This well-known species was represented in the collection from the Great Barrier Island by one male and one female, which have the following dimensions: Length of the body, ♀ 128 mm., ♂ 95 mm.; of mesothorax, ♀ 28 mm., ♂ 21 mm.; of metathorax, ♀ 25 mm., ♂ 19 mm.; of abdomen, ♀ 64 mm., ♂ 49 mm.; of antennæ, ♀ 29 mm., ♂ 29 mm.; of anterior femur, ♀ 36 mm., ♂ 24 mm.; of middle femur, ♀ 26 mm., ♂ 20 mm.; of posterior femur, ♀ 26 mm., ♂ 19 mm. The bases of all the femora are pale in colour, more broadly so in the male than in the female.

It is found throughout New Zealand, as far south as the West Coast Sounds of Otago.

Art. VI.—*New Zealand* Polyplacophora: *Keys to Genera and Species.*

By Henry Suter.

[Read before the Philosophical Institute of Canterbury, 2nd November, 1898.]

Key to Genera.

A. Valves lacking insertion plates .. .. .. *Lepidopleurus.*

AA. Valves possessing insertion plates, valves i.–vii. or i.–viii. having slits; teeth smooth or but slightly roughened between the slits, never closely, finely pectinated; valves lacking eyes.

B. Surface of intermediate valves divided into lateral and central areas by a diagonal (often indistinct) extending from beak to outer front angle of tegmentum; or, if this is not clearly the case, the posterior valve has an even, crescentic series of well-developed teeth; all valves having slits.

C. Posterior valve having a crescentic series of well-developed teeth.

D. Valves porous at the eaves. Sutural plates connected across the sinus, side-slits several (single in one species), girdle with compact diamond-patterned covering; gills as long as the foot .. .. *Callochiton.*

DD. Valves solid at eaves, girdle densely covered with flat imbricating scales, side-slits single .. .. *Ischnochiton.*

CC. Posterior valve having a sinus behind, without slits; girdle hairy or nude, never scaly .. .. .. *Plaxiphora.*

BB. Surface of intermediate valves divided into a narrow dorsal area and latero-pleural areas, the latter formed by the union of the lateral and the pleural areas; valves more or less covered by the naked spiculose or hairy (never scaly) girdle.

C. Girdle provided with pores bearing tufts of bristles .. .. *Acanthochites.*

CC. Girdle spongy, produced forward .. *Spongiochiton.*

AAA. All valves or valves i. to vii. possessing insertion plates cut into teeth by slits; the teeth sharply sculptured or "pectinated" outside by fine vertical grooves.

B. Valves lacking eyes.

C. Girdle scaly .. .. *Chiton.*

CC. Girdle leathery, with short bristles .. *Eudoxochiton.*

BB. Valves having eyes; posterior valve not deeply sinused behind, its insertion plate developed. Girdle covered with calcareous spines or spinelets .. .. .. *Acanthopleura.*

BBB. Valves having eyes upon the lateral areas and head-valve. Insertion plate of tail-valve reduced to a smooth ledge or ridge, having no posterior sinus. Girdle leathery, microscopically velvety .. .. .. *Onithochiton.*

Genus **Lepidopleurus**, Risso (1826).

L. inquinatus, Reeve.

Pilsbry, Man. Conch. (1), vol. xiv., p. 90, pl. xviii., figs. 49, 50.

Genus **Callochiton**, Gray (1847).

Key to Species.

A. Entire surface delicately shagreened .. .. *C. platessa.*

B. Central areas with elevated separate threads, parallel to jugum .. .. *C. illuminatus.*

C. A row of deep longitudinal pits in front of lateral areas .. .. *C. empleurus.*

C. platessa, Gould.

Pilsbry, Man. Conch. (1), vol. xiv., p. 49, pl. x., figs. 1–5. *Crocinus*, Reeve, and *versicolor*, A. Ad., are synonyms.

C. illuminatus, Reeve.

Pilsbry, Man. Conch. (1), vol. xiv., p. 51, pl. ix., figs. 92–94.

C. empleurus, Hutton.

Man. N.Z. Moll., p. 113.

Genus **Ischnochiton**, Gray (1847).

Key to Species.

Scales of girdle faintly striated, mingled with non-striated scales .. .. *I. longicymba.*

All scales of girdle deeply grooved, 3–4 grooves on a scale *I. parkeri.*

I. longicymba, Quoy and Gaimard.
Man. N.Z. Moll., p. 113.

I. parkeri, Suter.
Proc. Mal. Soc. London, vol. ii., p. 186 (1897).
Circumvallatus, Hutton (not of Reeve), is a synonym.

Genus **Plaxiphora**, Gray (1847).

KEY TO SPECIES.

A. Valves exposed.	
B. Posterior valve not greatly reduced in size or altered in form.	
C. Central areas unsculptured save for growth-lines.	
D. Sutural pores or tufts distinctly developed.	
E. Lateral areas with subobsolete radiating riblets	*P. superba.*
EE. Lateral areas with at least 2 distinct radiate ribs	*P. subatrata.*
DD. Sutural pores absent, girdle densely covered with bristles	*P. suteri.*
CC. Central areas sculptured, at least at the ..	
D. Large. Sutural pores with bifurcating bristles; girdle broad, reddish ..	*P. biramosa.*
DD. Small. Sutural pores with more than 2 bristles; girdle narrow, white or white and black	*P. cælata.*
BB. Posterior valve reduced to a narrow crescentic form, strongly arched upward	*P. ovata.*
AA. Valves partially immersed in the girdle, which encroaches at the sutures	*P. obtecta.*

P. biramosa, Quoy and Gaimard.
Man. N.Z. Moll., p. 116.

P. superba (Cpr.), Pilsbry.
Pilsbry, Man. Conch. (1), vol. xiv., p. 319, pl. lxviii., figs. 55–61.

P. cælata, Reeve.
Man. N.Z. Moll., pp. 115, 116.
Ziczac, Hutton, and *terminalis*, E. A. Smith, are synonyms.

P. suteri, Pilsbry.
Nautilus, vol. viii. (1894), p. 8.
Ciliata, Hutton (not of Sowerby), is a synonym: Man. N.Z. Moll., p. 116.

P. subatrata, Pilsbry.
Proc. Mal. Soc. London, vol. ii., p. 190 (1897).
Atrata, Hutton (not of Sowerby), is a synonym: Man. N.Z. Moll., p. 114.

P. obtecta (Cpr.), Pilsbry.
Pilsbry, Man. Conch. (1), vol. xiv., p. 330.

P. ovata, Hutton.
  Man. N.Z. Moll., p. 117.

Genus **Spongiochiton**, Carpenter (1873).

S. productus (Cpr.), Pilsbry.
  Pilsbry, Man. Conch. (1), vol. xiv., p. 26.

Genus **Acanthochites**, Risso (1826).

KEY TO SPECIES.

A. Anterior valve without radiating ribs; not obviously lobed around the lower edge of tegmentum.
  B. Tail valve with one slit on each side; girdle covered with spicules, and having well-developed tufts .. .. *A. zelandicus.*
  BB. Tail valve with several slits; girdle naked, leathery, covering the valves except for a linear band at the ridge; small tufts on tubercles .. .. *A. porosus.*
AA. Anterior valve having 5 radiating ribs, its lower margin 5 lobed. Girdle with 18 small pore-tufts.
  B. Girdle leathery, naked except tufts .. .. *A. violaceus.*
  BB. Girdle covered with white spicules, especially at the margin .. .. *A. rubiginosus.*

A. zelandicus, Quoy and Gaimard.
  Man. N.Z. Moll., p. 117.
  Hookeri, Gray, is a synonym.

A. porosus, Burrow.
  Man. N.Z. Moll., p. 118.
  Leachi, Blainville; *monticularis*, Q. and G.; *zelandicus*, Gray; (?) *depressus*, Blaine; (?) *stewartianus*, Rocheb., are synonyms.

A. violaceus, Quoy and Gaimard.
  Man. N.Z. Moll., pp. 117, 118.
  Porphyreticus, Reeve, is a synonym.

A. rubiginosus, Hutton.
  Man. N.Z. Moll., p. 114.
  Costatus, Suter (not of Ad. and Ang.), is a synonym.

Genus **Chiton**, Linné (1758).

KEY TO SPECIES.

A. Central areas having longitudinal riblets.
  B. Sides and ridge of central areas both sculptured.
    C. Lateral areas with numerous slightly crenulated threads.
      D. Intermediate valves carinated, divergence 120° .. .. .. *C. quoyi.*
    CC. Lateral areas with 3 or 4 rows of distinct tubercles .. .. .. *C. pellis-serpentis.*
  BB. Central areas with a smooth band or triangle on ridge of each valve.

C. Lateral areas with 4–6, pleura 16 or more, granose riblets	*C. canaliculatus.*
CC. Lateral areas with 4–8 divaricate riblets, pleura 20 furrows on each side ..	*C. æreus.*
CCC. Lateral areas with 2–4, pleura 8–14, nodulose riblets.	
D. Girdle-scales mucronated ..	*C. limans.*
DD. Girdle scales not mucronated ..	*C. stangeri.*
AA. Central areas smooth, no longitudinal ribs ..	*C. sinclairi*

C. quoyi, Deshayes.
Man. N.Z. Moll., p. 112.
Viridis, Q. and G., and *glaucus*, Gray, are synonyms.

C. æreus, Reeve.
Man. N.Z. Moll., p. 112. (N. Zeal.?)

C. pellis-serpentis, Quoy and Gaimard.
Man. N.Z. Moll., p. 111.

C. sinclairi, Gray.
Man. N.Z. Moll., p. 111.

C. canaliculatus, Quoy and Gaimard.
Man. N.Z. Moll., p. 112.
Stangeri, Pilsbry (not of Reeve), and *insculptus*, A. Ad., are synonyms.

C. stangeri, Reeve.
Man. N.Z. Moll., p. 111.

C. limans, Sykes.
Pilsbry, Man. Conch. (1), vol. xiv., p. 175, pl. xxxvii., figs. 12, 13.
Muricatus, A. Adams, and *sulcatus*, Hutton (not of Q. and G.), are synonyms.

Genus **Eudoxochiton**, Shuttleworth (1853).

KEY TO SPECIES.

A. Shell elevated, divergence 100–110°, anterior valve with 30 slits, spinelets black	*E. nobilis.*
AA. Shell depressed, divergence 135–140°, anterior valve with 17 slits, spinelets brown	*E. huttoni.*

E. nobilis, Gray.
Man. N.Z. Moll., p. 115.

E. huttoni, Pilsbry.
Pilsbry, Man. Conch. (1), vol. xiv., p. 194, pl. xlvi., figs. 96–100.

Genus **Acanthopleura**, Guilding (1829).

A. granulata, Gmelin.
Trans. N.Z. Inst., vol. iv., p. 180. Suter, Proc. Mal. Soc. London, vol. ii., p. 198.
Corticata, Hutton, is a synonym.

Genus **Onithochiton**, Gray (1847).

O. undulatus, Guoy and Gaimard.
Man. N.Z. Moll., p. 114.
Lineolata, Hutton (not of Frembly), is a synonym.

Art. VII.—*Revision of the New Zealand* Pleurotomidæ, *with Descriptions of Six New Species.*

By Henry Suter.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate III.

The diagnosis of the family is given by Tryon* as follows: "Shell fusiform, with a more or less produced anterior canal, and a slit or sinus of the outer margin of the aperture near the suture. Operculum (not always present) corneous, annular, the nucleus apical, or subcentral, or nearly marginal. The dentition is usually 1—0—1, but in some groups there is a rhachidian tooth, and in others there are two laterals. No jaws."

With regard to making a satisfactory classification, it may not be out of place to quote a few of Tryon's remarks on the subject†: "In no other group of Mollusca is it so difficult to make a satisfactory classification. Many species are very variable in their characters, whilst the material for the recognition of most of those described is generally scanty. The many generic and subgeneric groups that have been made only increase the confusion, for so great is the variability of all the characters that nearly allied species have been constantly separated into different groups."

As the dentition and operculum of most of the New Zealand species are unknown, the present classification rests on the characters of the shells alone, and is therefore open to amendment.

The deep-sea species hardly form part of the New Zealand fauna, but I include them here, as some of them may be found inhabiting our shores in lesser depths.

* Tryon, Man. Conch. (1), vol. vi., p. 151.
† *l.c.*, pp. 151, 152.

Sub-family PLEUROTOMINÆ.

Operculum oval, with terminal nucleus.

Genus PLEUROTOMA, Lamarck (1799).

Shell turriculated, fusiform; spire long, sharp; aperture ovate, columellar margin smooth, the outer lip with a narrow profound sinus situated rather distantly from the suture; canal long and narrow, straight, open. Dentition, 1—0—1.

Pleurotoma ischna, Watson.

Watson, Journ. Linn. Soc. London, vol. xv., p. 403 (1881); "Challenger" Exp. Rep., pt. 42, vol. xv., p. 208, pl. xxii., fig. 2 (1886).

Shell high, conical, blunt, with a contracted base and longish snout, little sculpture, strongish, yellowish-grey, porcelaneous. Lines of growth rising into tubercles on the upper whorls. Whorls 7, faintly keeled by a more prominent spiral thread; another similar close above the suture. Upper whorls reticulated. Mouth club-shaped. Sinus rather deep, open-mouthed.

Length, 8·5 mm.; breadth, 2·3 mm.

Type in the British Museum (Nat. Hist.).

Hab In 700 fathoms, off East Cape (Stat. 169, Chall. Exp.).

Genus GENOTIA, H. and A. Adams, em. 1853 (*Genota*).

Shell narrowly obconic, cancellated; body-whorl gradually tapering to a but slightly developed canal; lip-sinus wide and shallow; aperture long and narrow, with subparallel margins. Operculum unguiculate.

Genotia engonia, Watson.

Watson, Journ. Linn. Soc. London, vol. xv., p. 405 (1881); "Challenger" Exp. Rep., pt. 42, vol. xv., p. 300, pl. xx., fig. 7 (1886).

Shell fusiform, biconical, with a rounded keel angulating the whorls, and a broad lop-sided snout. Lines of growth crossed by close-set spiral threads, somewhat granular below the keel. Colour porcelaneous-white. Whorls 8, with a slightly concave shoulder. Suture slightly canaliculated. Mouth rhomboidally pear-shaped, with a broad open anterior canal.

Length, 32 mm.; breadth, 13·2 mm.

Type in the British Museum (Nat. Hist.).

Hab. In 700 fathoms, off East Cape (Stat. 169, Chall. Exp.); one specimen. Obtained also off Inosima, Japan, in 345 fathoms.

Genus Drillia, Gray (1838).

Shell turriculated, with longitudinal ribs and usually revolving striæ; last whorl usually short; spire elevated; columella with a posterior callus; outer lip thick, but not varicose nor dentate within, flexuous, with a well-marked posterior sinus near (but not reaching) the suture, and an anterior constriction or sinuosity; canal short, curved, usually narrow.

Key to Species.*

1. Shell without distinct spiral lyræ .. .. *D. lævis.*
2. Shell with distinct spiral lyræ .. .. *D. amœna.*

Drillia lævis, Hutton.

Hutton, Cat. Mar. Moll. of N.Z., p. 12 (1873); Man. N.Z. Moll., p. 44 (1880); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 51, pl. vii., fig. 32 (1893).

Shell fusiform, the spire longer than the body-whorl. Whorls smooth, with longitudinal plications, about fourteen on the last whorl, pale yellow-brown with a central spiral band of pink. Aperture oval; canal short and straight; sinus deep; mouth and columella white, shading off into pink. Animal unknown.

Length, 18 mm.; breadth, 7 mm.; angle of spire, 30°.

Type in the Colonial Museum, Wellington.

Hab. Foveaux Strait. Found also in the Pliocene of New Zealand.

Drillia (?) amœna, E. A. Smith.

Smith, Ann. Mag. Nat. Hist. (5), vol. xiv., p. 318 (1884).

Shell fusiform, light flavescent, with a white band encircling the whorls; eight convex volutions, the first two smooth, the others longitudinally costate; 18 ribs on the last whorl, not continuing below the periphery; spirally lyrate, the lyræ forming nodules on crossing the ribs, 5 to 6 lyræ on the upper whorls, about 15 on the last, few without nodules at the base. Aperture two-fifths of the whole length of the shell; canal narrow, but little produced.

Length, 14 mm.; breadth, 5 mm.

Type in the British Museum (Nat. Hist.).

Hab. New Zealand.

Two of the spiral lyrations a little below the suture are finer than the others. The whorls are markedly convex, and the apical ones are large. (E. A. S.)

I have not seen this species.

Genus Spirotropis, Sars (1878).

Shell turriculated, rather thin; apex obtuse; whorls carinated; sinus profound, distant from the suture. Operculum normal. Dentition very distinct; formula, 1—1—1—1—1.

Spirotropis bulbacea, Watson.

Watson, Journ. Linn. Soc. London, vol. xv., p. 418 (1881); "Challenger" Exp. Rep., pt. 42, vol. xv., p. 325, pl. xxv., fig. 9 (1886).

Shell broadish, conical, sharply keeled, with a shortish contracted base and a short snout, short narrow ribs, and coarse spiral threads, a bulbous apex; strong, porcelaneous. Ribs slightly tubercled at top. The spirals marginating the suture. Spire short. Whorls 6½, short, concavely shouldered. Mouth narrowly oval; sinus blunt, V-shaped. Operculum oval, with hair-like striæ; apex terminal.

Length, 12·7 mm.; breadth, 5·8 mm.

Type in British Museum (Nat. Hist.).

Hab. In 700 fathoms, off East Cape (Stat. 169, Chall. Exp.). Known from no other locality.

This species is near *Surcula trailli*, Hutton, but the longitudinal ribs are less numerous, the canal much shorter, and the colour different.

Sub-family CLAVATULINÆ.

Operculum pyriform, with lateral internal nucleus.

Genus SURCULA, H. and A. Adams (1853).

Shell turriculated, fusiform; spire long; lip-sinus in the infrasutural depression above the peripheral carina; canal long, slightly bent. Operculum with medio-lateral nucleus. Dentition, 1—0—1.

KEY TO SPECIES.

1. Whorls spirally ribbed or sulcate.
   - *a*. Usually with 3 strong spiral ribs .. .. *S. albula*.
     - *aa*. Whorls shouldered, grooved .. .. *S. cheesemani*.
     - *bb*. Whorls not shouldered, sometimes without grooves or only a few .. .. *S. varians*.
2. Whorls longitudinally ribbed.
   - *a*. Suture not margined .. .. .. *S. gypsata*.
   - *b*. Suture margined.
     - *aa*. Longitudinal plications very numerous *S. novæ zelandiæ*.
     - *bb*. About 15 oblique ribs on the last whorl *S. trailli*.
     - *cc*. About 9 strong tubercles on the last whorl .. .. *S. verrucosa*.

Surcula novæ-zelandiæ, Reeve.

Reeve, Conch. Icon. (*Pleurotoma*), spec. 143 (1843). Hutton, Cat. Mar. Moll. N.Z., p. 11 (1873); Man. N.Z. Moll., p. 43 (1880). Tryon, Man. Conch. (1), vol. vi., p. 184, pl. xii., figs. 42, 44. *P. rosea*, Quoy and Gaimard, Voy. Astrol., Zool., vol. ii., p. 524, pl. xxxv., figs. 10, 11 (not of Sowerby). *P. quoyi*, Deshayes,

Lam. Anim. s. Vert., 2nd ed., vol. ix., p. 346 (not of Desmoulins).

Shell spirally sulcate and longitudinally striate, the suture slightly impressed, marginate and subcrenulate; sinus rather broad and shallow; rose-ash colour, purple-rose within the aperture. Aperture oblong, canal short; body-whorl rather longer than the spire. Animal unknown.

Length, 28 mm.; breadth, 10 mm.; angle of spire, 25°.

Type in the British Museum (Nat. Hist.).

Hab. Throughout New Zealand. Specimens kindly given to me by Mr. S. H. Drew were dredged off Wanganui.

Surcula trailli, Hutton.

Hutton, Cat. Mar. Moll. of N.Z., p. 11 (1873); Man. N.Z. Moll., p. 42 (1880). Tryon, Man. Conch. (1), vol. vi., p. 206, pl. xxxiv., fig. 90. *D. maorum*, E. A. Smith, Ann. Mag. Nat. Hist. (4), vol. xix., p. 497 (1877); Hutton, Man. N.Z. Moll., p. 44 (1880). *P. buchanani*, Hutton, Man. N.Z. Moll., p. 42 (1880); Tryon, Man. Conch. (1), vol. vi., p. 208 (not *P. buchanani*, Hutton, Cat. Tert. Moll. of N.Z., p. 4 (1873)).

Shell fusiform, turreted, pale rose-colour; whorls 8½, the first 1½ smooth, spirally lyrated, concavely shouldered; suture margined, with about 16 oblique ribs. Aperture elongated, canal somewhat elongated, narrow; sinus moderate, situated in the excavation. Animal unknown.

Length, 21 mm.; breadth, 7 mm.; angle of spire, 28°.

Type in the Colonial Museum, Wellington.

Hab. Throughout New Zealand. The type was dredged in 24 fathoms, near Stewart Island. Orakei, near Auckland (H.S.).

I quite agree with Captain Hutton that this is not the same as *Drillia æmula*, Angas, as suggested by Tryon (*l.c.*, p. 206, pl. xii., fig. 37), which occurs on the coast of New South Wales.

Surcula albula, Hutton.

Hutton, Cat. Mar. Moll. of N.Z., p. 12 (1873); Man. N.Z. Moll., p. 43 (1880); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 49, pl. vi., fig. 22 (1893). *S. antipodum*, E. A. Smith, Ann. Mag. Nat. Hist. (4), vol. xix., p. 491 (1877); Hutton, Man. N.Z. Moll., p. 43 (1880).

Shell fusiform, white; whorls spirally grooved, with fine growth-lines in the grooves, and a central prominent spiral rib; whorls 7½; aperture oblong, contracted below; canal short, recurved. Body-whorl nearly half the entire length of shell. Sinus shallow, above the keel. Animal unknown.

Length, 10 mm.; breadth, 4 mm.; angle of spire, 30°.

Type in the Colonial Museum, Wellington.

Hab. Throughout New Zealand. Auckland Harbour (H. S.) Found also in the Pliocene of New Zealand.

Surcula cheesemani, Hutton.

Hutton, Journ. de Conchyliologie (1878), p. 16; Man. N.Z. Moll., p. 44 (1880); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 49., pl. vi., fig. 24. *D. zealandica*, E. A. Smith, Ann. Mag. Nat. Hist. (4), vol. xix., p. 492 (1877); Hutton, Man. N.Z. Moll., p. 43 (1880), (not *novæ-zelandiæ*, Reeve).

Shell ovato-fusiform, the spire gradated, flesh-white, apex brownish; whorls 10, first 2½ polished, slightly convex, keeled above, tabulations strongly radiately striated, with 2 to 3 sulci. Body-whorl large, somewhat inflated, contracted towards the base; with about 12 strong sulci, longitudinally striated. Columella darkish, canal short, slightly recurved. Sinus rather broad and sometimes deep, situated below the broad furrow which grooves the upper part of the whorls. Animal unknown.

Length, 23 mm.; breadth, 9 mm.

Type in the Canterbury Museum.

Hab. Auckland Harbour. Found also in the Pliocene of New Zealand.

Surcula gypsata, Watson.

Watson, Journ. Linn. Soc. London, vol. xv., p. 413 (1881); "Challenger" Exp. Rep., pt. 42, vol. xv., p. 292, pl. xxv., fig. 1 (1886).

Shell strong, fusiform, biconical, scalar; shortly, sharply, and obliquely ribbed, keeled, constricted at the suture, with a long and rather inflated body-whorl and a largish snout. Sinus broad, deep, and rounded.

Length, 44·5 mm.; breadth, 19 mm. Aperture: Length, 24·4 mm.; breadth, 12 mm.

Type in the British Museum (Nat. Hist.).

Hab. In 700 fathoms, off East Cape (Stat. 169, Chall. Exp.); two specimens (dead shells).

Surcula varians, Hutton.

Hutton, Trans. N.Z. Inst., vol. xvii., p. 314, pl. xvii., fig. 2 (1885); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 44, pl. vi., fig. 16 (1893).

Shell oblong, the spire prominent and acute. Whorls 7, flattened, spirally grooved. Grooves variable, sometimes only one on the anterior half of the whorl, sometimes several are equally distributed all over; generally there is a smooth band without grooves on each whorl; sometimes the spire-whorls are quite smooth, or with one or two grooves only. Suture

deep. Aperture less than half the length of the shell, oval, with the right lip flattened; the posterior canal well marked; columella smooth and rounded; the anterior canal very short; right lip toothed within.

Length, 10 mm.; breadth, 4 mm.

Type in the Canterbury Museum.

Hab. Dunedin Harbour (A. Hamilton). Foveaux Strait.

This species, described from Pliocene fossil shells, and classed under *Columbella*, has been obtained by dredging in Dunedin Harbour and Foveaux Strait, and careful examination of a series of fossil and recent specimens has convinced me that it really belongs to the *Pleurotomidæ*, and I think its proper place is in the genus *Surcula*, although operculum and dentition are unknown. There is a distinct posterior sinus below the suture, shallow and rounded.

Surcula verrucosa, n. sp. Plate III., figs. 1, 1*a*.

Shell fusiform, turriculated, spire longer than the body-whorl, yellowish-brown. Whorls 7, spirally striated, keeled by a row of tubercles; 2 to 3 spiral striæ run across the nodules, a rather broad one is situated below the suture; there are about 9 tubercles on the last whorl, and 6 to 7 strong cinguli below them. Protoconch smooth, mammillary, consisting of 1½ volutions. Suture impressed, margined. Aperture oval; outer lip thin, sharp, with a broad shallow posterior sinus in front and above the nodules; columella arched, but slightly callous; anterior canal short, almost straight. Animal unknown.

Length, 9·5 mm.; breadth, 4 mm.; height of aperture, 4 mm.

Type in my collection.

Hab. Foveaux Strait (A. Hamilton).

This species resembles somewhat *Drillia angasi*, Crosse, from Australia and Tasmania, which, however, is larger, with a broader spire and very fine close spiral striæ, the suture not margined, and the posterior lip-sinus deeper and narrower. From the Pliocene *S. tuberculata*, Kirk, which it also approaches somewhat, it may at once be distinguished by the large much less numerous tubercles on the whorls and the shorter anterior canal.

Sub-family MANGILIINÆ.

No operculum.

Genus Mangilia (Leach, M.S.), Risso, em., 1826 (*Mangelia*).

(= *Bela*, Leach, M.S.), Gray, Proc. Zool. Soc., 1847, p. 134.)

Shell fusiform, imperforate; aperture oval-elongated, usually narrow, terminating in a rather short truncated canal; lip-sinus near the suture. Dentition, 1—0—1.

KEY TO SPECIES.

1. Whorls cancellated.	
a. Spire as long as the body-whorl, about 15 ribs on the last whorl	*M. ula.*
b. Spire longer than the body-whorl, about 11 ribs on the last whorl	*M. dictyota.*
2. Whorls not cancellated, longitudinal ribs predominant.	
a. Spire about the length of the body-whorl, about 18 straight ribs on the body-whorl	*M. subaustralis.*
b. Spire longer than the body-whorl.	
aa. Ribs continuous over the whorls, about 10 on the last whorl, with spiral rows of red dots	*M. goodingi.*
bb. Shell minute, about 16 flexuous ribs on the last whorl	*M. flexicostata.*

Mangilia goodingi, E. A. Smith.

Smith, Ann. Mag. Nat. Hist. (5), vol. xiv., p. 320 (1884).

Shell acuminately ovate, turriculate, white, ornamented with series of red dots on the ribs, one above the periphery, another near the base of the whorls; there are 7 volutions, the first two convex, the following slightly shouldered, almost flat; ribs continuous; 9 to 10 prominent plicate ribs on the last whorl, continuing to its base; the whole shell with minute close spiral striæ; the body-whorl with a third series of red dots towards the base. Aperture narrow, less than half the length of the shell; outer lip thickened, slightly sinuated; canal narrow, short.

Length, 7·5 mm.; breadth, 2·7 mm.

Type in the British Museum (Nat. Hist.).

Hab. New Zealand. Foveaux Strait (A. Hamilton).

The five prominent plicate ribs, which in the single specimen before me are continuous up the spire, and the spiral row of reddish dots on the ribs, two on the upper whorls and three on the last, are the principal distinctive characters of this very elegant species (E. A. S.).

Mangilia ula, Watson.

Watson, Journ. Linn. Soc. London, vol. xv., p. 420 (1881); "Challenger" Exp. Rep., pt. 42, vol. xv., p. 312, pl. xxii., fig. 1 (1886).

Shell rather short, fusiform, biconical, scalar, angulated, obsoletely ribbed and with rather strong spiral threads. Snout rather short, broadish and lop-sided. In the shoulder a shallow, open, rounded sinus.

Length, 6 mm.; breadth, 3 mm. Aperture: Length, 3 mm.; breadth, 1·5 mm.

Type in the British Museum (Nat. Hist.).

Hab. In 700 fathoms, off East Cape (Stat. 169, Chall. Exp.); one specimen. Obtained at no other locality.

Mangilia dictyota, Hutton.

Hutton, Trans. N.Z. Inst., vol. xvii, p. 316, pl. xviii., fig. 8 (1885); Pliocene Moll of N.Z., Macleay Mem. Vol., p. 53, pl. vii., fig. 37 (1893).

Shell minute, elongato-fusiform, the whorls slightly angled and cancellated. Longitudinal ribs narrow and distant, about 11 in a whorl. Spire-whorls with 3 strong distant spiral ribs, the interstices finely spirally striated; body-whorl with about 9 spiral ribs, the posterior three larger and alternating with a small rib as well as the spiral striæ. Aperture oval, nearly half the length of the shell; posterior sinus broad and shallow; anterior canal moderate.

Length, 6 mm.; breadth, 3 mm.

Described from a fossil shell of the Pliocene.

Colour of shell white, sometimes light-brown. In some specimens a brown band appears on the base of the penultimate whorl, and is continued on the body-whorl. Columellar lip mostly dark-violet or brown, especially the lower part of it. The spiral sculpture is variable in its conspicuity. Animal unknown.

Type in the Canterbury Museum.

Hab. Auckland Harbour (H. S.). Lyall Bay (A. Hamilton). Foveaux Strait. Chatham Islands.

This species is no doubt nearly allied to *M. connectens*, Sow., and *M. cuspis*, Sow., from South Australia.

Mangilia subaustralis, n. sp. Plate III., figs. 2, 2*a*.

Shell fusiform, white, spire as long as the body-whorl. Whorls 6½, shouldered, longitudinally plicate and spirally striate; the plicæ, about 18 on the last whorl, are smooth, between them equidistant cinguli, which are much closer together from below the upper suture to the keel. Suture impressed, submargined. Protoconch consisting of two minute acute and smooth whorls. Aperture elongately oval, angled above; outer lip thin, sharp, sinuated, with a shallow posterior sinus near the suture, above the keel; columella slightly concave, with a very thin callus; canal short, straight. Animal unknown.

Length, 11·5 mm.; breadth, 4·5 mm.; height of aperture, 6 mm.

Type in my collection.

Hab. New Zealand; exact locality unknown. One specimen only.

This shell is very closely allied to *M. australis*, Ad. and Ang., from Australia and Tasmania, which, however, is usually larger; the whorls are but indistinctly shouldered, the aperture not angled above, and the anterior canal broader.

Mangilia flexicostata, n. sp. Plate III., figs. 3, *3a*.

Shell minute, oval-elongated, spire longer than the body-whorl, white, semi-transparent. Whorls 5, narrowly shouldered, with flexuous plicæ, about 16 on the last whorl, microscopically spirally striate. Protoconch $1\frac{1}{2}$ whorls, smooth, minute. Suture deep. Aperture oval, angled above, outer lip somewhat thickened, sinuous, with a broad shallow sinus just below the suture. Columella arcuate, slightly callous; anterior canal short, rather oblique, truncated. Animal unknown.

Length, 2·25 mm.; breadth, 1·25 mm.

Type in my collection.

Hab. Foveaux Strait (A. Hamilton).

Genus CLATHURELLA, Carpenter (1857).

(=*Defrancia*, Millet, 1826.)

Apex mammillary; sinus varicose, sutural; columella tuberculated posteriorly, rugose in front; canal slightly curved.

Differs principally from *Mangilia* in its whorls being more rounded and cancellate.

KEY TO SPECIES.

1. With nodulous spiral ribs	*C. nodicincta.*
2. Spirally striate, longitudinal ribs predominant.	
a. Suture margined	*C. subabnormis.*
b. Suture not margined	*C. sinclairi.*

Clathurella sinclairi, E. A. Smith.

Smith, Ann. Mag. Nat. Hist. (5), vol. xiv., p. 320 (1884). Tryon, Man. Conch. (1), vol. vi., p. 283, pl. xxxiv., fig. 91 (1884). *D. letourneuxiana*, Hutton, Cat. Mar. Moll. of N.Z., p. 12 (1873), (not of Crosse). *D. luteofasciata*, Hutton, Man. N.Z. Moll., p. 45 (1880), (not of Reeve).

Shell ovate, subturriculated, light-flavescent, with two reddish intercostal bands at the sutures; whorls 8, convex, the first ones flattish, with rounded rather low ribs, 16 on the last whorl, continuing nearly to the base; whorls spirally more or less distinctly lyrate, the lyræ unequal and continuous between and across the ribs. Aperture small, fasciated within with fuscous, length $\frac{5}{11}$ of the total length of the shell; outer lip sharp, with a shallow sinus a little below the suture; snout fuscous; columella with a very small callus; canal very short, oblique. Animal unknown.

Length, 11 mm.; breadth, 4·5 mm.

Type in the British Museum (Nat. Hist.).

Hab. Throughout New Zealand. Chatham Islands. Found also in the Pliocene of New Zealand.

This is a very variable shell with regard to size and num-

ber of longitudinal ribs. In specimens before me they vary from 10 to 16 on the last whorl. The reddish-brown bands are sometimes absent, the anterior canal only being of a brown or reddish colour.

Clathurella subabnormis, n. sp. Plate III., figs. 4, 4*a*.

Shell small, ovate-fusiform, body-whorl shorter than the spire, white, with irregular light-brown dashes below the suture on the two last whorls only, and a broad brown band below the termination of the riblets on the body-whorl; sometimes the whole shell is uniformly light-brown. Whorls 6, rounded, longitudinally plicate and spirally striate; about 14 oblique riblets on the body-whorl, which are crossed by distinct spiral striæ, about 8 on the penultimate whorl. Protoconch formed by two smooth mammillary whorls. Suture impressed, margined. Aperture oval-elongated, outer lip somewhat callous, sometimes with 2 or 3 small tubercles within, slightly sinuous, posterior sinus but faintly indicated; columella regularly arched, with a slight callosity; anterior canal very short, broad, truncated. Animal unknown.

Length, 5·5 mm.; breadth, 2·5 mm.; height of aperture, 2 mm.

Type in my collection.

Hab. Lyall Bay (A. Hamilton).

This species is nearest to the Pliocene *C. abnormis*, Hutton, in which, however, the whorls are angled, the costæ less numerous, the spiral striæ but a few, none above the keel, the sinus is well marked, and the aperture much narrower.

Clathurella nodicincta, n. sp. Plate III., figs. 5, 5*a*.

Shell fusiform, turreted, body-whorl shorter than the spire, cream-coloured, clathrate. Whorls 6½, with strong elevated cinguli, 3 on the upper whorls, 8 on the body-whorl, crossed by longitudinal straight riblets, producing nodules on the crossing-points; between the riblets numerous fine incremental striæ. In most of my specimens the cinguli are predominant, the longitudinal costæ recognisable only by the presence of the nodules on the cinguli. Protoconch smooth, mammillary, consisting of 2 whorls. Suture impressed, margined by a fine thread above. Aperture oval, outer lip thickened, somewhat straight in the middle, with 2 small denticles within; posterior sinus below the suture broad and very shallow, sometimes absent; columella concave, but little callous. Anterior canal short, broad, truncated. Animal unknown.

Length, 6·5 mm.; breadth, 2·75 mm.; height of aperture, 2·5 mm.

Type in my collection.

Hab. Lyall Bay (A. Hamilton).

Genus DAPHNELLA, Hinds (1844).

Shell thin, fragile, oval-fusiform; whorls convex; body-whorl elongated, surface finely cancellated; aperture oval; lip simple, not varicose, arcuated; canal very short.

Type: *Pleurotoma lymneiformis*, Kiener.

KEY TO SPECIES.

1. Spire shorter than the body-whorl.	
a. Surface finely but distinctly and regularly cancellated or only nodulous spiral striæ on the body-whorl	*D. lymneiformis.*
b. Surface microscopically, rather irregularly cancellated.	
aa. Whorls rounded	*D. membranacea.*
bb. Whorls shouldered	*D. xanthias.*
2. Spire longer than the body-whorl.	
a. Surface with longitudinal fine ribs	*D. protensa.*
b. Surface only spirally finely striated	*D. substriata.*
3. Spire about the same length as body-whorl, spirally ribbed, minute	*D. lacunosa.*

Daphnella lymneiformis, Kiener.

Kiener, Icon. Pleurotoma, p. 62, pl. xxii., fig. 3; Tryon, Man. Conch. (1), vol. vi., p. 300, pl. xxv., fig. 60, pl. xxvi., fig. 93 (1884). *D. cancellata*, Hutton, Journ. de Conch, 1878, p. 18; Man. N.Z. Moll., p. 45 (1880). *D. decorata*, C. B. Adams, Conch. Contr., p. 62. *D. patula*, Reeve, Proc. Zool. Soc., 1845, p. 113. (The two latter synonyms are given on the authority of Tryon.)

Shell fusiform, thin, spire acute; whorls with narrow, close, revolving ridges, the earlier ones with longitudinal ribs; white, irregularly maculated with chestnut, often forming longitudinal zigzag markings. Aperture oblong, slightly channelled in front, and with a slight posterior sinus. Animal unknown.

Length, 12·7 mm.; breadth, 5 mm.

Type in the Musée de Paris (?).

Hab. Auckland Harbour. Cape Maria van Diemen. Found also in the Pliocene of New Zealand.

Daphnella lacunosa, Hutton.

Hutton, Trans. N.Z. Inst., vol. xvii., p. 317 (1885); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 52, pl. vii., fig. 34 (1893).

Shell minute, fusiform. Whorls 5, the first two smooth, the others with strong spiral ribs at equal distances. Spire-whorls with 3, body-whorl with 10 or 12 of these ribs; the grooves rather broader than the ribs, and smooth. Aperture ovate, about half the length of the shell; the sinus obsolete; canal short, outer lip thin.

Length, 5 mm.

Described from a fossil shell of the Pliocene.

The shell is white, semi-transparent. The animal is unknown. Specimens before me from Foveaux Strait and Chatham Islands are much smaller than the fossil forms.

Length, 3 mm.; breadth, 1·5 mm.

Type in the Canterbury Museum.

Hab. Foveaux Strait (A. Hamilton). Chatham Islands.

Daphnella substriata, n. sp. Plate III., figs. 6, 6*a*.

Shell thin and fragile, small, oval-fusiform, spire longer than the body-whorl, white, apex light-violet, finely spirally striated throughout, except the protoconch. Whorls 6, rounded, with delicate equal and numerous fine spiral striæ. Protoconch mammillary, rounded, smooth, light-violet. Suture superficial, submargined. Aperture elongated oval, outer lip simple, sharp, slightly sinuous, posterior sinus but faintly indicated. Columella concave, with a thin shining callus; anterior canal short, broad, truncated, slightly recurved. Animal unknown.

Length, 5·5 mm.; breadth, 2·25 mm.; height of aperture, 2·25 mm.

Type in my collection.

Hab. Foveaux Strait (A. Hamilton).

Very closely allied to *D. striata*, Hutton, of the New Zealand Pliocene, but this species is of much larger size (length up to 30 mm.), the protoconch is keeled, and the following whorls are slightly shouldered; the spiral striæ are unequal, broader ones alternating with smaller ones; the incremental striæ are much more conspicuous, and the anterior canal is mostly longer and narrower.

Section Raphitoma, Bellardi (1847).

Shell small, fusiform or turriculated, with longitudinal sculpture; lip sinuous behind, but without well-defined sinus.

Daphnella protensa, Hutton.

Hutton, Trans. N.Z. Inst., vol. xvii., p. 317 (1885); Pliocene Moll. of N.Z., Macleay Mem. Vol., p. 49, pl. vi., fig. 25 (1893). *P. awamoaensis*, Hutton, Trans. N.Z. Inst., vol. xv., p. 131 (1883); Tryon, Man. Conch. (1), vol. vi., p. 208, pl. xii., fig. 25. (Not *P. awamoaensis*, Hutton, Cat. Tert. Moll. of N.Z., p. 4.)

Shell small, thin, turreted, yellowish-white; whorls 8½, the first ones smooth and convex, afterwards slightly carinated; longitudinally finely ribbed, 15 to 20 ribs on the last whorl, and spirally lyrate; upper part of the whorls not con-

cave; canal moderate, aperture elongately oval, posterior sinus very slight. Animal unknown.

Length, 9 to 13 mm.; breadth, 3 to 4·3 mm.

Type in the Canterbury Museum.

Hab. Waiwera, near Auckland. Found also in the Pliocene of New Zealand.

Section THESBIA, Jeffreys (1867).

Shell thin, rather smooth, somewhat tumid, with a short spire and irregularly contorted apex; aperture slightly expanded, the outer lip thin, with distinct sinus; canal short; columella simple.

Daphnella membranacea, Watson.

Watson, "Challenger" Exp. Rep., pt. 42, vol. xv., p. 333, pl. xxvi., fig. 9 (1886).

Shell singularly unlike a *Pleurotoma*, being broad, short, tumid, and membranaceously thin; spire short; whorls with fine, irregular, hair-like lines of growth; crossed by very slight, remote, irregular spirals. Colour white. Base long, gradually contracted; snout broad, lop-sided; sinus close to the suture, deep, wide.

Length, 22 mm.; breadth, 13·5 mm.

Type in the British Museum (Nat. Hist.).

Hab. In 1,100 fathoms, off Cape Turnagain (Stat. 168, Chall. Exp.). Obtained at no other locality.

Daphnella xanthias, Watson.

Watson, "Challenger" Exp. Rep., pt. 42, vol. xv., p. 334, pl. xxvi., fig. 10 (1886).

Shell oval, biconical, a little tumid; spire high and conical, base long and pointed. Surface smooth, feebly spiralled, spirals flat threads, absent above the shoulder; fine hair-like lines of growth. Whorls shouldered; sinus at the suture, deep, broad.

Length, 19·5 mm.; breadth, 10 mm.

Type in the British Museum (Nat. Hist.).

Hab. In 1,100 fathoms, off Cape Turnagain (Stat. 168, Chall. Exp.). Obtained at no other locality.

EXPLANATION OF PLATE III.

Fig. 1. *Surcula verrucosa*, Suter; × 3.
Fig. 2. *Mangilia subaustralis*, Suter; × 3.
Fig. 3. *Mangilia flexicostata*, Suter; × 10.
Fig. 4. *Clathurella subabnormis*, Suter; × 4.
Fig. 5. *Clathurella nodicincta*, Suter; × 4.
Fig. 6. *Daphnella substriata*, Suter; × 6.

Art. VIII.—*Notes on New Zealand* Galaxidæ, *more especially those of the Western Slopes: with Descriptions of New Species, &c.*

By F. E. Clarke.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

Plates IV. and V.

Though the common eels are almost the most ubiquitous of our fresh-water fishes (in spite of statements made that in some streams the prevalence of waterfalls prevents their passage to the upper waters), due merit must also be given to the equal or greater prevalence of more or less varieties of the *Galaxidæ*. As our Islands are famed for remains of varieties of struthious birds, so we should gather ichthyological fame for the great number of varieties of those fishes, and it would be most interesting if evidence should be obtained of their geological existence also. It is a most engaging family, not only on account of its affinities with or resemblance to the *Salmonidæ* and *Esocidæ*, but also on account of its known extended habitat in the Southern Hemisphere—Western Australia, South Australia, Victoria, Queensland, Tasmania, New Zealand, Chatham Islands, Chili, Patagonia, Tierra del Fuego, and Falkland Islands.

The family certainly arrives at its greatest known development in our Islands, and its least—as far as has been described at present—in the southern parts of South America.

One of the members of the family—*G. attenuatus*—periodically descends to the sea in January, February, and March, where it spawns, returning in March, April, and May. The young begin to make their appearance in the rivers sometimes as early as the end of June, but they definitely commence to arrive in August, the shoals increasing in size and number in September and October, and keep practically unmixed with other fry until the end of October. At this time, and in November, the shoals begin and continue to consist of a mixed character—fry of *Eleotris*, *Retropinnæ*, and *Prototroctes* forming a greater percentage of them till the in-run ends. The young fry of *Eleotris* in November are thickly swarming. They and the fry of the *Retropinnæ* evidently follow the fry of *G. attenuatus* until they are large enough to prey on them. Frequently you will see small or tiny *Retropinnæ* or *Eleotris* with a half-gorged whitebait sticking out of their mouths almost equalling in size the swallowers.

The extent of the shoals of the whitebait in the South Island west coast rivers at times was incredible; often I have seen the surface of the Chinamen's gardens at the Buller, Grey, Teremakau, Hokitika, &c., for several acres each in extent, covered some inches in depth with these fry, used as top-dressing manure. This was when an expressly heavy run occurred, making it non-practicable for our Celestial migrants to dispose of them at a price which they considered paid for the labour of hawking; or when the shoals were too greatly mixed with "cock-a-bullies"; or when they were too lazy to dry and export them to China, which they sometimes did to a considerable extent, especially when the more periodical large shoals of smelts were running. These they carefully dried and packed in strong "upper" leather bags for export, obtaining from 3s. 6d. to 5s. per pound for the dried article from the middleman or "boss," who probably reaped a much greater price still in China. This wholesale destruction for manure purposes, I am happy to say, was of late years stopped by preventing the use of the long shingle abutments with the set nets at intervals. It was piteous at those times to see the enormous quantities of young grayling (upokororo) which were destroyed.

Now that the whitebait (*Galaxias attenuatus* fry) is being utilised for canning—which is beginning to form a considerable industry—one hopes that the supply will last, and be properly fostered, to allow sufficient to be left for annual reproduction. But a safeguard in this is that it will be impossible to collect from all the rivers the supplies required for the canneries, and I expect it will be some little time before they are established on any but a few of the larger ones.

The Maoris of the West Coast, South Island, called the young fry "inanga" and the adult fish the "mai-tai," or "mahitahi," or, as they described it, "te whaea o te inanga."

At the time of the advent of the fry I have frequently, and at several places, seen large shoals of the "inanga" at sea, and have caught specimens in verification, and have constantly observed them washed up by the breakers on to the beaches near the mouths of the large rivers, evidently when skirting the coast to enter them, and I have seen them dragged on shore in estuaries by the ground-ropes of the seine. A spate in the whitebait rivers will prevent the inrun until the fresh is over.

The early-run fish keep their immaculate colour much longer in the fresh water than those which come in towards the end of the season, these last, in fact, sometimes beginning to darken after a few hours' sojourn in the fresh element.

The Europeans of the West Coast, South Island, call the adult fish "cents" or "scents," whilst the youth of Taranaki

District designate them "mingies"—I suppose an evolution from "minnows," by which name they are commonly known in many other parts of New Zealand.

The whole of the family are very voracious fish, the most meek- and harmless-looking *attenuatus* being proportionately the worst in that respect. When turning out trout-fry (by necessity, not having developing-ponds therefor) at that supremely ridiculous age which by absurd fad had been adopted by so many for their liberation—I allude to the period soon after absorption of the umbilical sac—I have often seen three or four of these ubiquitous little rascals rush into the shoal—from goodness knows where—even when the greatest precautions had been taken in selection of a site comparatively free from them—and with lightning-like darts here and there avail themselves of the expensive change of diet so easily afforded, and completely decimate them in a very few minutes.

In captivity, both in the pond and aquarium, experiments ranging over many years have shown that *G. attenuatus* must return to salt water, otherwise it dies. A certain proportion each year have to take their departure to the ocean or be provided with salt water if their continuation in life is required.

G. attenuatus runs up to the heads of all streams, of whatever size and almost of whatever nature. Even the most trivial of little "trickles" of water will be found to be inhabited by them. Dark or clear, thin or thick water—none comes amiss.

They very seldom exceed a total adult length of 6 in. The largest ever observed by me in either of the other colonies or New Zealand in an experience of forty-four years was barely 7 in. in length. Average length of adult fish, 4½ in. to 5 in. (total). *Attenuatus* will take a fly, in brisk or still water; and in its adult state is a sweet little fish gastronomically.

As this species is ocean-frequenting, its greater extension of habitat is not so much to be wondered at, but it is difficult for one to surmise whether this capacity is an evidence of enhanced development or not. Certainly, in its corporeal characteristics, as compared with the more giant types we possess, and which I refer to hereafter, it has in my idea depreciated in type.

So far as my researches have gone in the streams of the North Island, the place of the five larger varieties of the family (as enumerated by Professor Hutton*) frequenting those of the South Island are occupied by *G. fasciatus* and *G. abbreviatus* only. Numerous native names are given by several authorities for varieties. These might represent two or three definite species, but more probably only mean the local native

* Trans. N.Z. Inst., vol. xxviii., p. 317.

names given to the two different species I mention at various stages of their growth, in accordance with their usual system of nomenclature, by which a human being might be "Brown" when a boy, "Smith" as a hobbledehoy, or become "Robinson" in old age. My own observations are largely strengthened by inquiries amongst our survey class of bush-wanderers, who have an unfailing aptitude for discovery of anything in the edible variety on legs, wings, or using fins. Mr. H. M. Skeet is the only one of the latter who has informed me he has found a spotted variety, but I still live in hope of finding the existence of some of our southern types, especially as *Neochannæ* are common to the two Islands.

The larger *Galaxias* of the Taranaki streams, though coloured like *fasciatus* and answering in other respects to the description of that species, certainly, in those I have examined, does not, in position of ventral and anal fins, agree with the arrangement of Professor Hutton before quoted; and, in addition to the three other varieties I describe at length, I have also given a new description of this fish, with a drawing for comparison (Plate V.).

With due deference to Professor Hutton's division of the New Zealand species before referred to, I cannot quite get all the types I have found in Westland to correspond with his divisions as extant; and, viewing his close attention and large scope of observation in matters scientific, &c., I am of the idea that two of the Westland types may not have come under his ken, and am positive that one has not. The last one of these is an interesting one, as more resembling *Neochanna* in form, "if the ventrals were wanting," than any of the hitherto described *Galaxidæ*.

For some years after 1870—the date of my arrival in New Zealand—at occasional intervals I obtained a few isolated specimens of this fish amongst fry of *G. attenuatus*, *Retropinna richardsonii*, *Eleotris gobioides*, and *Prototroctes oxyrhynchus*, the heterogenous collection making up the so-called "whitebait" of the end of the inanga season in the Westland rivers, though, strange to say, in my long experience and ceaseless watching, season after season, I never found amongst this collection the fry of any of the larger indigenous Westland *Galaxidæ*. It was not until 1887 that I got an adult fish, one being caught by Mr. H. L. Robinson when fishing for grayling (upokororo) in the Hokitika River, just above Glossop's Ferry. Since that date I have taken them—but very occasionally—in the Kanieri River and Lake, Kawhaka Creek, Frosty and South Creeks, and the tributaries of the last mentioned, which can best be depended upon for the production of a specimen, as they are not by any means common. I have designated this variety *G. robinsonii*.

Another of the Westland species I refer to, which, though agreeing perhaps in some measure with *alepidotus*, in greater particulars differs. These differences, with all the varieties I now deal with, I have—by description and tabular arrangements prepared on even system—rendered easier for inspection and comparison. I give two drawings of this species also, to show the distinction between the more moderate-sized and larger fish; but the principal points of comparison remain constant (Plate IV.). This variety grows to such constant large size that it would have been more appropriately called *grandis*, if the late Professor von Haast had not already adopted such specific name for the fish Professor Hutton now classifies as a variety of *G. brevipinnis*. However, as the South Island west coast Maoris always call this species "kokopu," and as such name has not yet been specifically used, I propose to distinguish it as *Galaxias kokopu*.

G. kokopu is of excessively slow growth as compared with the rest of the family, and prefers to frequent those smaller rivers and streams which have rocky or hard gravelly beds. It is sometimes caught in the larger snow-fed rivers, but only occurs there—in my experience—near the mouths of tributaries with the features noted. It evidently does not like too great a continuous current to exist in, as is generally the case with the Westland wholly snow- or snow- and rain-fed, large, open, shingle-bedded rivers—practically huge mountain torrents—as you occasionally find, after spates, a specimen or two washed up on the beaches at the mouths of such rivers as have suitable tributaries near their embouchure to the ocean.

Professor Haast writes, in his article on *G. grandis**: "This species occurs also at the West Coast, where I obtained it in Lake Hall [Paringa Lake], the outlet of which falls into the Paringa River." This shows he must have observed this West Coast variety I now refer to without having properly defined it at the time, as he obtained and described his *grandis* some years after his visit to South Westland; also, *G. kokopu* is commonly obtained in the streams about the Paringa Valley, and north and south of it, of which more anon.

Kokopu differs from *grandis* in very many points, nothing but the colour—apart from the other general family characteristics—being deducible from the description as at all corresponding; and this colour, though described as "yellowish spots and short streaks," is noted as "on the back and head they are small and of rare occurrence," which is quite different from *G. kokopu*. Neither, as before mentioned, does it agree with the principal points of *alepidotus*, as defined by

* Trans. N.Z. Inst., vol. v., p. 278.

Günther (Cat. Fishes, vol. vi., p. 208), by Captain Hutton's "Catalogue of Fishes of New Zealand" (p. 58), or Professor Hutton's divisions as before mentioned; nor with *brocchus*, which Günther (*ib.*, p. 210) defines as a variety of *fasciatus* and Professor Hutton as one of *alepidotus*. I have captured them year by year in Westland—from 1870 to 1894—of all sizes, from a couple of inches to a maximum total length of 23 in. and weight of 6 lb., and in all they keep their robust proportions, though the very large ones appear to have a finer head, on account of the greater development of the "corporation." They take the fly very fairly, especially if it is presented in the form of a large live moth or blow-fly, and in captivity in the aquarium make very handsome and docile pets, soon learning to put their heads out of the water to take a blow-fly from the fingers. As with the English brown-trout, the larger fish are perfect tyrants, and keep the whole of a large pool under subjection. After catching the very large ones, of which a pool will only contain three or four, the next in size, but of larger number, become apparent, and take possession. These, when caught, are represented by a still smaller but more numerous draft. I presume these come out of the very numerous nooks and crannies and sheltering-places about small and large snags, where they are comparatively safe from the pursuit of the large tyrants. To enable these to appear again the pool must be left in abeyance for two or three seasons. The spots, crescents, and old Arabic-script-like markings of this fish are much larger in proportion in the smaller fish, but always keep of the same general figure; and this species I have found, like *abbreviatus*, proves most constantly free from aberration.

In the time of the notorious "Hunt's Rush" to South Westland it was a godsend to the hungry and fast-travelling prospectors, who, on following up the rocky-pool streams running down the sides of the lower ranges abutting on the sea-coast, obtained easy and welcome supplies of the large ones, thus affording, as several told me, "a good galvanised-iron bucket full of solid-fleshed food for the evening meal, and a breakfast as well." Their flesh is white and sweet, and very good if properly cooked, but, being so solid, requires quite double the time of cooking most fish.

In the very hot and dry late summer and autumn seasons —which you get to perfection in the usually much-maligned West Coast, South Island, climate—when the pools in the creeks and streams which it inhabits are much curtailed thereby, and get a "bloom" on the surface (in miniature like the "Indian summer" of North America), this variety is occasionally infested with a long thin red flesh-worm, which cysts up in the flanks, and also lies in the thick muscles along

the back. These, when the water improves, eat their way bodily out through the exterior.

Kokopu feeds a great deal on the fresh-water lobster, and has many of the habits of the Home trout—inhabiting the deeper streams, lying close to the surface at times, sometimes sheltering under a patch of foam at the foot of a miniature cascade or fall, and rising to the surface in the evening and taking the flies or moths.

The third Westland species I enlarge upon, more frequently inhabits the sluggish and muddy-bottomed creeks, but is also found in company with *G. kokopu* in the gravel-bottomed and some of the rocky creeks. In its proportions it somewhat approximates to the description of *fasciatus*, though it grows much larger, but seldom beyond 10 in. in length. It is not as hardy in the aquarium as *G. kokopu,* and has generally the same feeding habits, except that it does not take a surface-bait as well. Strange to say, it is seldom, if ever, troubled with the flesh-worms before mentioned. I have distinguished this one with the specific name of *postvectis,* on account of its peculiar and constant marking.

Order PHYSOSTOMI.

Family Galaxidæ.

Genus **Galaxias**.

	Fin-ray Formulæ and Branchiostegous Rays. D.	P.	V.	A.	C.	B.R.
Galaxias kokopu	14	13–14	7	15–16	16	8
„ *postvectis* ...	11	14	7	15	16	8
„ *robinsonii* ...	13	15	7	15	16	8
„ *fasciatus* ...	10	13	7	13	16	9

	Vertebræ.	Head is to Total Length.
Galaxias kokopu ...	35 + 26 = 61 ...	As 3 is to 13
„ *postvectis* ...	35 + 25 = 60' ...	„ 5 „ 23
„ *robinsonii* ...	35 + 25 = 60 ...	„ 7 „ 41
„ *fasciatus* ...	(not counted) ...	„ 3 „ 16

G. kokopu (larger fish).—Length without caudal = $3\frac{7}{8}$ that of head (with caudal, $4\frac{1}{3}$).

G. kokopu (smaller fish).—Length without caudal = $3\frac{2}{3}$ that of head (with caudal, $4\frac{1}{3}$).

G. postvectis.—Length without caudal = 4 that of head (with caudal, $4\frac{3}{5}$).

G. robinsonii.—Length without caudal = $5\frac{2}{7}$ that of head (with caudal, $5\frac{6}{7}$).

G. fasciatus.—Length without caudal = $4\frac{2}{3}$ that of head (with caudal, $5\frac{1}{3}$).

G. kokopu (larger fish).—Depth of body under dorsal contained a little more than $4\frac{1}{2}$ times in length, without caudal.
G. kokopu (smaller fish).—Depth of body under dorsal contained about 5 times in length, without caudal.
G. postvectis.—Depth of body under dorsal contained $5\frac{1}{2}$ times in length, without caudal.
G. robinsonii.—Depth of body under dorsal contained $7\frac{3}{4}$ times in length, without caudal.
G. fasciatus.—Depth of body under dorsal contained $5\frac{1}{5}$ times in length, without caudal.
G. kokopu (larger fish).—Greatest depth of body contained about 4 times in length, without caudal.
G. kokopu (smaller fish).—Greatest depth of body contained about $4\frac{1}{3}$ times in length, without caudal.
G. postvectis.—Greatest depth of body contained about $4\frac{3}{4}$ times in length, without caudal.
G. robinsonii.—Greatest depth of body contained about $7\frac{3}{4}$ times in length, without caudal.
G. fasciatus.—Greatest depth of body contained a little less than 5 times in length, without caudal.

In *G. kokopu* and *G. postvectis* the length of head is greater than depth of body under origin of dorsal by distance from snout to margin of orbit.

In *G. fasciatus* the length of head is greater than depth of body under origin of dorsal by half-distance snout to orbit.

In *G. robinsonii* the length of head is greater than depth of body (which is of even depth from back of head to origin of dorsal) by $\frac{3}{7}$.

In *G. kokopu* (small fish), *G. postvectis*, and *G. fasciatus* the length of head exceeds the greatest depth of body, but less so in small *G. kokopu* and *fasciatus* than in *G. postvectis;* but in large *G. kokopu* the length of head equals the greatest depth of body.

G. kokopu.—Diameter of eye = $\frac{1}{8}$ length of head, and about $1\frac{1}{3}$ in snout.
G. postvectis.—Diameter of eye = $5\frac{1}{2}$ in length of head, and about $1\frac{1}{3}$ in snout.
G. robinsonii.—Diameter of eye = little over 8 in length of head, and about $2\frac{1}{3}$ in snout.
G. fasciatus.—Diameter of eye = 6 times length of head, and about $1\frac{1}{2}$ in snout.
G. robinsonii.—Diameter of orbit 7 times in head, and about 2 in snout.
G. kokopu.—Length of pectoral = half-distance of its root from ventral.

G. postvectis.—Length of pectoral = $\frac{1}{16}$ more than half-distance of its root from ventral.

G. robinsonii.—Length of pectoral = $\frac{1}{14}$ more than half-distance of its root from ventral.

G. fasciatus.—Length of pectoral = $\frac{1}{12}$ more than half-distance of its root from ventral.

G. kokopu.—Ventrals terminate $\frac{1}{4}$ height from vent; extreme length pectorals and ventrals equal.

G. postvectis.—Ventrals terminate $\frac{1}{3}$ height from vent; ventrals exceed pectorals in extreme length.

G. robinsonii.—Ventrals terminate more than extreme height from vent; pectorals exceed ventrals in extreme length.

G. fasciatus.—Ventrals terminate about $\frac{1}{3}$ height from vent; pectorals exceed ventrals in extreme length.

G. kokopu.—Least depth of tail a little shorter than from end of dorsal to origin of caudal.

G. postvectis.—Least depth of tail $\frac{1}{4}$ shorter than from end of dorsal to origin of caudal.

G. robinsonii.—Least depth of tail $2\frac{1}{8}$ times in distance from end of dorsal to origin of caudal.

G. fasciatus.—Least depth of tail $\frac{1}{8}$ shorter than distance from end of dorsal to origin of caudal.

G. kokopu.—Anal, if laid backwards, barely reaches base of caudal.

G. postvectis.—Anal, if laid backwards, does not reach base of caudal.

G. robinsonii.—Anal, if laid backwards, nearly twice its height from base of caudal.

G. fasciatus.—Anal, if laid backwards, reaches to base of caudal.

G. kokopu.—Origin of pectorals exactly half-distance to ventrals.

G. postvectis.—Origin of pectorals less than half-distance to ventrals by $\frac{1}{11}$ height of pectorals.

G. robinsonii.—Origin of pectorals trifle more than $\frac{2}{5}$ distance to ventrals.

G. fasciatus.—Origin of pectorals less than half-distance to ventrals by $\frac{1}{8}$ height of pectorals, or $\frac{1}{8}$ distance snout to ventrals.

G. kokopu.—Origin of pectorals to origin of ventrals much more than half-distance to anal.

G. postvectis.—Origin of pectorals to origin of ventrals more than half-distance to anal.

G. robinsonii.—Origin of pectorals to origin of ventrals very little more than half-distance to anal.

G. fasciatus.—Origin of pectorals to origin of ventrals more than half-distance to anal.

G. kokopu.—Origin of ventrals much beyond midway between length to base of caudal.

G. postvectis.—Origin of ventrals a little beyond midway between length to base of caudal.
G. robinsonii.—Origin of ventrals diameter of orbit less than midway between length to base of caudal.
G. fasciatus.—Origin of ventrals diameter of orbit less than midway between length to base of caudal.
G. kokopu.—Origin of ventrals less than midway in total length.
G. postvectis.—Origin of ventrals much less than midway in total length
G. robinsonii.—Origin of ventrals depth of body less than midway in total length.
G. fasciatus.—Origin of ventrals extreme length base of dorsal less than midway in total length.
G. kokopu.—Distance to origin of pectorals much exceeds distance ventrals to anals.
G. postvectis.—Distance to origin of pectorals a trifle more than distance ventrals to anals.
G. robinsonii.—Distance to origin of pectorals but two-thirds distance ventrals to anals.
G. fasciatus.—Distance to origin of pectorals about same as distance ventrals to anals.
G. kokopu.—Distance to origin of pectorals much exceeds distance origins anal and caudal.
G. postvectis.—Distance to origin of pectorals equals distance origins anal and caudal.
G. robinsonii.—Distance to origin of pectorals four-fifths distance origins anal and caudal.
G. fasciatus.—Distance to origin of pectorals a trifle shorter than distance origins anal and caudal.
G. kokopu.—Extreme length base of dorsal much greater than depth of gape of mouth.
G. postvectis.—Extreme length base of dorsal less than depth of gape of mouth.
G. robinsonii.—Extreme length base of dorsal greater than depth of gape of mouth.
G. fasciatus.—Extreme length base of dorsal equals the depth of gape of mouth.
G. kokopu.—Height anal less than base, but exceeds depth ventrals or distance dorsal to origin caudal.
G. postvectis.—Height anal exceeds base, but less than depth ventrals or distance dorsal to origin caudal.
G. robinsonii.—Height anal exceeds base, but less than depth ventrals or half-distance dorsal to origin caudal.
G. fasciatus.—Height anal equals base, and equals depth ventrals and distance dorsal to origin caudal.
G. kokopu.—Lower jaw projects beyond upper whether closed or open.

G. postvectis.—Lower jaw about same length as upper when shut, but projects beyond when open.
G. robinsonii.—Upper jaw projects beyond lower either closed or open.
G. fasciatus.—Upper jaw scarcely projects beyond lower.
G. kokopu.—The maxillary extends to the vertical from rear margin of pupil of eye.
G. postvectis.—The maxillary extends to about vertical from centre of pupil of eye.
G. robinsonii.—The maxillary extends to the vertical from middle of eye.
G. fasciatus.—The maxillary extends to the vertical from rear margin of orbit.

Galaxias kokopu.

Body very stout; head broad and depressed, slightly flat on top. Fins very fleshy and thick, especially the vertical ones, which also have a thick fleshy pad at their foot, hiding the bases of the rays altogether, first three rays of dorsal and anal being completely hidden. Origin of dorsal slightly in advance of that of anal. Anal higher than dorsal. Ventrals and pectorals each longer than height of dorsal, but less than height of anal. Caudal much rounded. Dorsal immediately over vertical from anal orifice. Width of caudal at base equals three long diameters of orbit or width of head at rear of orbit. Ribs thin, long, and needle-like.

This species has mature ova in November.

Colour.—The ground-tint of sides, back, and head more or less dark pinkish-brown of beautiful transparent tint when the fish is in good condition and alive, but varying in intensity with the class of water frequented. The belly light pinkish-grey, sometimes with quite a golden or bronzed colour. The whole of the sides, back, cheeks, and base of vertical and tail fins more or less closely spotted and marked with rounded spots, and more or less crescent-shaped, and short slightly sinuous or small ring-like marks, some quite old Arabic-script-like in character, and in colour light yellowish-brown or ochre. The spots and marks on the back become much smaller and closer; those on head smaller still, more rounded, and invariably arranged concentrically. The vertical fins and tail are blackish. Pectorals and ventrals lighter. Iris of eye golden, with bluish patches.

Measurements of 11·05 in. specimen are appended.

The Westland people generally call this species the "mountain-trout."

Galaxias postvectis.

Body is stout, of squarer section than *G. kokopu;* head also flattened on top, but not so much depressed. Fins are not

very fleshy, the first rays of vertical ones only being buried in membrane. Base of dorsal shorter than that of anal; anal higher than dorsal. Extreme length of dorsal and pectoral equal. Caudal is not so much rounded as in *G. kokopu*. Vertical from origin of dorsal a little posterior to anal orifice. Ribs are thicker in comparison than those of *G. kokopu*.

Colour.—Ground-tint pinkish olive-brown, lighter or darker according to class of water. The rearward portion of body only, from about half-way between ventrals and anal, has the sides barred with from 7 to 9 darkish-brown lines, each slightly curved, and thicker along the median line, the apex pointing forwards, the bars diminishing in intensity of colour anteriorly. The rest of the body is unmarked, except a purplish patch bordered with lighter above origin of pectorals. The fins are light-brown, golden-pink in some lights. Iris of eye golden.

This species is not in full roe until December, and is generally called in Westland the "barred trout."

Measurements of specimen 6·35 in. in length are appended.

Galaxias robinsonii.

Body much elongated and rounded, slightly flattened on back and belly, where the median depressions are well marked. Thickness equalling depth almost to origin of dorsal; from thence to tail the sides are flattened, and body compressed. The eye is small, and set in a much larger orbit. The cheeks are very fleshy and tumid, the opercular divisions being completely indistinguishable thereby without dissection. Caudal fin is slightly emarginate, the angles of lobes, however, being much rounded. The other fins also are very much rounded, and are excessively fleshy and opaque, the general epidermis covering fully two-thirds of their respective free portions. This renders the fin-ray enumeration very difficult without absolute dissection of each ray of the vertical fins especially. The formulæ of dorsal and anal externally read 9 and 10 rays, but three first of dorsal and anal are very small and fine, completely imbedded in the dark cuticle, and the last rays of same are very fine and close together. The pectorals are placed very low down on ventral surface, and are quite pedunculated; they originate immediately at termination of gill-openings. Two teeth on each side of lower jaws are much enlarged. The maxillaries have their exposed portions very large and tumid as compared with other *Galaxidæ*. The anal orifice has a double small papillary appendage. Top of head is wide, but flattened portion is short. Ribs much thicker in proportion than in any other species of this family I am acquainted with.

Pectoral fins are larger than ventrals, and, though the extreme height of dorsal and anal and their basal lengths slightly differ, they are practically of the same size. The origin of dorsal is so far in advance of that of anal that a line arising vertically from last intersects middle of base of dorsal.

Colour.—Ground light bluish-grey, minutely spotted with darker grey and light-brown, and generally spotted and marbled on sides, fins, and tail with dark olive-brown. The spots on back, head, cheeks, and under dorsal (especially the last) are very much the larger. One light patch or semi-band above ventrals and another commencing low down in advance of vertical from origin of dorsal extending back over anal. Belly the general ground colour. Iris of eye golden.

Measurements of specimen described attached.

Galaxias fasciatus.

Last ray of dorsal and anal are double. Longest rays of dorsal exactly equal in height longest rays of pectoral, and equal distance from posterior margin of eye to free margin of gill-covers, equals depth in vertical through posterior margin of eye, and equals the direct distance between the termini of bases of dorsal and anal fins. The longest rays of caudal fin equal the extreme length from superior origin of pectoral to rear free margin of such fin, and also equals the extreme width of body. The eye-opening is inclined to be slightly oval, the larger diameter being the vertical one. The origins of dorsal and anal are in the same vertical. Top of head over eyes slightly rounded, behind eyes flattened. The median depressions along back and belly well marked. The width of gape equals its depth. The commencements of fins are fleshy, the first rays of each being quite imbedded in such, remainder of fins being more generally free from fleshy thickening, and rays approximating in appearance therefore to *G. abbreviatus.* Cheeks and head are fleshy, hiding opercular divisions. Ribs are much shorter than those of *G. kokopu, postvectis,* or *robinsonii.* In full roe and milt end of October.

Colour.—Rose-brown mottled with darker on the sides and back, and with light-coloured reticulating markings on the back, and 16 or 17 light-coloured irregular transverse large markings or bands along the sides, which are margined on their forward edges with a darker tint. A large irregular bluish marking above the origins of pectorals. Vertical fins darkish and mottled. Iris golden.

Measurements of specimen 8 in. in length appended.

The left-hand branchiostegous curtain overlaps the right-hand portion under the throat. Four branchial arches.

Plate IV. shows *Galaxias kokopu,* 15¼ in. and 11 in. total

length; and Plate V. shows *G. postvectis*, 6·35 in.; *G. robinsonii*, 8·2 in.; and *G. fasciatus*, 8 in.—total lengths. The drawings of the fishes are all reduced to the same length, for greater facility in comparisons.

I must apologize for extending my literary matter on the subject to such length, but without doing so it was impossible to bring the various points of difference or resemblance under easy inspection.

—	*Galaxias kokopu.*	*Galaxias postvectis.*	*Galaxias robinsonii.*	*Galaxias fasciatus.*
	In.	In.	In.	In.
Total length	11·05	6·35	8·2	8·0
Length of head	2·5	1·36	1·4	1·5
Greatest depth	2·1	1·15	1·0	1·40
Greatest width	..	..	1·0	..
Length to base caudal	9 5	5·55	7·5	6·85
Length to origin dorsal ..	7·25	4·15	5·40	5·15
Length to origin pectorals ..	2·7	1·36	1·4	1·625
Length to origin ventrals ..	5·4	2·85	3·6	3·65
Length to origin anal	7·4	4·20	5·7	5·15
Distance pectorals to ventrals ..	2 86	1.6	2·2	2 05
Distance ventrals to anal ..	2·15	1·4	2·1	1 5
Depth body at ventrals ..	2·0	1·1	1·0	1·4
Depth body at dorsal	1·8	1·0	1·0	1·3
Depth body at end anal ..	1·07	0·7	0·65	0·8
Length base of dorsal	1·0	0·55	0·62	0·70
Length base of anal	1·4	0·7	0·65	0 94
Origin ventrals to base caudal ..	4·2	2·63	4·0	3·20
Dorsal to base caudal (centre) ..	1·45	0·85	1·50	1·00
Anal to base caudal (centre) ..	1·1	0·65	1·30	0·8
Length to centre of eye ..	0 85	0·46	0·5	0·5
Greatest height of dorsal ..	1·22 (7th ray)	0·8 (5th ray)	0·7 (7th ray)	0·85
Greatest height of anal ..	1·45 (8th ray)	0·85 (8th ray)	0·8 (8th ray)	0·92
Greatest length of ventral ..	1·35 (3rd ray)	0·87 (4th ray)	0·86 (5th ray)	0·92
Greatest length of pectoral ..	1·35 (4th ray)	0·8 (5th ray)	1·1	1·06
Greatest length of caudal ..	1·50	0·95	0·8	1·14
Width of caudal at base ..	1·35	0·7	0·95	1 0
Centre eye to pectoral	1·9	0·95	1·0	1·15
Width head at rear of eyes ..	1·35	0·70	..	..
Width head at rear of gill-openings	1·85	0·95	..	..
Vertical diameter of eye ..	0·40	0·25	0·13	0·26
Horizontal diameter of eye ..	0·45	0·25	0·13	0·25
Diameter of orbit	0·45	0·25	0·22	0·25
Width interorbital space ..	..	..	0·52	..
Least width of tail	1·07	0·7	0·55	0·8

Art. IX.—*On* Exocœtus ilma: *a New Species of Flying-fish.*

By F. E. Clarke.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

Plate VI.

It is not without due consideration and careful watching of this species for a long period that I have the honour of introducing it to your notice. The first specimen I obtained carries memory back to a universally known figure in the New Zealand Union Steamship Company's service, some few years ago entombed in a watery grave—I allude to the late Captain John McIntosh. Whilst on a voyage from the west coast of the South Island to Sydney in May, 1882, in the s.s. "Alhambra," having gained an offing of eighty to a hundred miles from the land we left the previous evening, I was on deck at sunrise, it being a beautiful clear morning, with but the lightest breeze and a long, low, lazy swell. Whilst walking up and down the deck with the above-mentioned officer a small flight of flying-fish arose from the sea, and passed, with one exception, over the vessel, rising above the awning then stretched over the quarter-deck. The exception came on board between the rail and the awning, falling almost at our feet. "A happy omen, Clarke," the captain exclaimed, "you shall have it cooked for your breakfast." I picked it up, and, after examining it, replied, "No, captain, I think it is a new variety from the great length of its fins; I will embalm it in some of the steward's best gin or whisky *pro tem.*, and devote its body to a more scientific fate."

Since that date several of the same kind were washed ashore on the coast of Westland, whilst one was caught on a light line by Mr. Harry Breeze, of Hokitika, when fishing for *Agonostoma* ("aua," so-called herring or sea-mullet) from the beach. Several of these were carefully examined and compared by me with my original drawing and notes, and exhibited the same characters as my type specimen, and all, strange to say, were about the same size. It has also come under my observation on shore, once on the coast of Taranaki; and twice whilst on the sea, when fishing from or paddling in a Rob Roy canoe, flying-fish, which arose from the water close by the canoe, had apparently the same large black type of pectorals. It may be useful to record that several times since my residence here flying-fish have been reported to me as having been seen off the end of our breakwater.

Dr. Günther, in his "Study of Fishes," says the flying-fish "are more frequently observed in rough weather and in a disturbed sea than during calm." And also he agrees with what is usually published, that "the fins are kept quietly distended, without any motion, except an occasional vibration caused by the air whenever the surface of the wing is parallel with the current of the wind"; also, that "in the day-time they avoid a ship, flying away from it." My experience of these fishes differs from these remarks, and my inquiries for years amongst "sailor-men" have generally substantiated this where their observation has been evidently carefully directed to them. Of course, it can be understood from the varying development of the pectoral and ventral fins in the numerous species that some differences of flight habits must occur; those in which the pectorals and ventrals are much less in comparison with the size of the body may safely be accredited with less powers of direct progression through the air, and probably an incapacity for turning or wheeling in flight at all. And these generally are the characteristics of the Atlantic species.

The result of my observations and inquiries is that more are observed in calm weather or light breezes; that swerving or wheeling in flight is fully within the capacity of most of those species frequenting the Indian Ocean, the seas of the Malay Archipelago, the China seas, and the equatorial and South Pacific towards the coast of New Zealand and in the Tasman Sea; that they frequently resort to the presence of a large boat or ship for protective shelter from their enemies, as is evidenced from such habit being taken advantage of by the fishermen, who capture them when so doing—*vide* the accounts of the flying-fish harvest off the shores of the Bermudas, &c.—and from the low-waisted native traders along the Indian coasts being easily able to attract them aboard by the exhibition of lights for such purpose at night; that they in daylight come aboard in about the same ratio as at night-time, when no attractive special display of lights is made; that a continuous vibrating movement is given to the pectorals in aerial flight. I have been, myself, in such a favourable position when the fish have arisen from the sea that a vibratory hum has been audible—almost the same kind of clashing noise as is noticeable in the flight of the larger dragon-flies. Those which came on board vessels in which I have been travelling did so in the day-time. One flew through a port-hole—in the old "City of Hobart"—and dropped into a hand-basin, after striking against the body of my sister, who was washing her hands and face therein. No doubt they would avoid a ship as much as possible, and perhaps do, unless under the circumstances previously quoted, which

are exemplified by several other varieties of fishes; but the vessels' disturbance of them in the water, especially if a steamboat, is frequently, I think, a cause of their misdirection of flight.

Order PHYSOSTOMI.

Fam. SCOMBRESOCIDÆ.

Genus Exocœtus.

Third division, ventral fins long, extending beyond posterior termination of base of anal.

Exocœtus ilma, sp. nov.

D., 12; P., 16; V., 6; A., 12; C. (7 upper limb, 8 lower limb), 15.

B., 8. L.L., 28 scales to origin of ventrals; 25 from same to termination of line which finishes before caudal is reached; 29 scales between occiput and origin of dorsal; and 6 longitudinal series of scales between origin of dorsal and lateral line. (This is common also with three other species of *Exocœtus.*) *Speculiger* also has same number, occiput to origin of dorsal, but according to Günther 6 to 7 between each point and lateral line.

Height of body is contained six and seven-tenths times in the total length (without caudal)—viz., if such length is reckoned along the median line from tip of snout to termination of the fish at the base of the central caudal rays—but if such height is compared with the total distance from snout to the vertical of origin of rudimentary rays of caudal, then it is contained in the latter six and a quarter times. This height of body is greatest and equal in that space between the verticals from a little posterior to the origin of pectorals and at the origin of ventrals.

Günther's description of *speculiger* gives one-sixth or nearly one-seventh of the total length (without caudal) as the proportion of depth, and in *nigripinnis* one-sixth or a little less than one-sixth total length (without caudal). Four other species in this division of *Exocœtus* are described with the same proportion as one-sixth, and four of it as a sixth and a half, which broadly means that about such a proportion appertains to the *Exocœti* with long ventral fins.

The length of the head is contained five and a half times in the total length (without caudal) first defined—*i.e.*, a proportion of two-elevenths. Günther's descriptions of *speculiger* and *nigripinnis* give head as two-ninths. The snout is very obtuse and short; on Plate VI. its peculiarities are reproduced. In its profile it is abrupt; the lower jaw projects beyond the upper when mouth is closed; therefore the chin forms the

most prominent portion of the tip. The lower jaw is also the longer when the mouth is fully open, and the jaws have some slight capacity of protrusion. The mouth is very small. A few very minute, short, thick, recurved teeth in a double row at the tip of the lower jaw and a single row of the same description around tho centre third of the upper jaw. There is a small, round, hard nodule at that posterior higher angle of the preorbital immediately adjoining the margin of orbit. The length of snout from anterior margin of eye, with mouth closed, exactly equals half the diameter of the eye. (In *speculiger* the snout is rather produced, and very nearly equals the diameter of the eye.) The eye, as compared with the size of the head, is very large, its diameter being contained twice and a little more than a half in the length of the head. (The eye of *speculiger* is one-third the length of head, that of *nigripinnis* two-fifths.) The interorbital space in a line even with the anterior margins of eyes exceeds the diameter of the eye, and in even line with posterior margins of eyes exceeds diameter of eye by one semi-diameter. This space is almost flat, being but slightly depressed in median line, the profile of such depression slightly convex, as are the supraorbital spaces. The top of the head at the interorbital space and to the occiput is free from scales, bony, and hard. The depth of head (under the vertical from occiput) equals the distance between the tip of snout and vertical falling through the posterior margin of preoperculum. The body is thick and robust, the back—which, with the top of the head, is slightly flattened—being much the wider. Sides and cheeks are also flattened, but incline towards the ventral edge, the lower part of the body being thus narrower and more angular, especially under the head and throat, though still stoutish.

The pectoral fins are wide and long, extending, when closed, to considerably beyond the commencement of the rudimentary rays of the caudal fin. Ventral fins commence exactly midway between verticals of posterior margin of eye and "root of tail." They also are long and broad, and extend, when laid back, almost to midway between the terminal line of anal and commencement of rudimentary rays of caudal. The two external rays of caudal fin adjoining the rudimentary rays are quite stout. The dorsal commences a little in advance of the plane of anal, but terminates exactly in same plane as anal. The scales are large, the larger averaging quite $\frac{3}{10}$ in. in width when detached from their sacs. Attached they have so great an overlap as to make them appear much smaller. The series forming the lateral line are much smaller, each being provided with tubular mucous duct. They are arranged directly on the epidermis; the general scales both above and below partially overlap them. The eyes are pro-

vided with the external transparent membranes or eyelids, with vertical oval aperture, so frequently met with in many of the pelagic surface or medium-depth fishes.

Colour: The top of the head and back brownish-purple; cheeks, sides, and part of the belly silvery, with golden reflections; the lower part of the belly pure white. The exterior surface of the pectorals when closed are covered with a silvery integument almost up to its tip, this being caused by the external portions of the rays being so covered; when spread the intervening membrane is very dark-brown. The whole of the interior surface of the pectorals is uniformly a very dark brown, almost black. Ventral fins uniform dark-brown, almost black. Dorsal and anal fins immaculate. Upper and lower limbs of caudal brown, central portion immaculate.

The pectoral fins of *speculiger* have "an oblique white band across its lower half" and "a broad whitish edge," whilst its "ventrals are white, the middle rays greyish."

	In.
Total length (snout to "root of tail" end of body, along median line thereof at caudal)	7·7
Length of head ..	1·4
Greatest depth of body	1·15
Greatest diameter of eye	0·55
Greatest height of dorsal	0·7
Greatest height of anal	0·65
Length of dorsal ..	1·22
Length of anal ..	1·15
Greatest length of pectorals	5·7
Greatest length of ventrals	2·55
Distance from anterior margin of orbit to tip of snout (end of chin)	0·275
Length of lower limb of caudal	2·2
Length of upper limb of caudal	1·6

Art. X.—*Notes on Parore (the Mangrove Fish).*

By F. E. Clarke.

[Read before the Wellington Philosophical Society, 14th March, 1899.]

Plate VII.

On Wednesday, the 9th August, 1896, there was brought to me by Mr. Busche, one of the fishermen then carrying on his calling at Moturoa, a fish which he did not know. This, on first seeing, I apprehended was one of those referred to by

Sir J. Hector (Trans. N.Z. Inst., vol. vii., p. 245) as the "parore." Subsequent examination disclosed that it was a *Girella*, not *simplex*, on account of its different scale enumeration, specially marked colouration, proportions, and its teeth being all tricuspid. I then made my coloured drawing, and prepared a very full description, as, though in some particulars it resembled *simplex*, in others it does *tricuspidata*, and in colouration *Tephrœops zebra*—which, according to Günther's Catalogue, is known from a drawing only, and is attributed to King George's Sound (West Australia).

I was much pleased, on visiting the waters of the far north of this Island lately, to find that my specimen was the parore, a fish excessively plentiful on the water-covered mangrove-flats and generally about the harbours, it being a great nuisance to the mullet-fishermen on account of its unwittingly occupying net-space which they consider should properly belong to the more valuable fish they seek to capture, and, moreover, being a very painful fish to handle in taking out of the mesh, as it has stout and sharp dorsal spines which it knows how to use. As I also found out, they occasionally play on the surface, when in a shoal, somewhat after a method also followed by the kanae, and therefore in the early morning, or just at dusk, deceive the netter, who encloses his fish under the impression that he has successfully surrounded kanae, instead of their (so-called) "lovely sweet-briars" (a nickname given them, I apprehend, from an equal or greater facility for affording their victims acquaintance with their prickles).

As the tide rises over the mangrove-flats you may see these fish feeding in hundreds at times, frequently in such shallow water that when scraping the confervoid or diatomaceous growths from the bottom or from the tougher weeds, small mangrove-shoots, &c., which are covered with the same, and feeding head downwards, the tails of dozens will simultaneously appear out of the water with a very comical effect. They take the tips of the stronger seaweeds, small kelps, &c., into their mouths, and then, backing, strip the vegetable, &c., growths therefrom. This they do both off the more exposed shores as well as over the mangrove-flats, &c. I never could get them to take a bait, as might be expected from their feeding habits; nor did I ever hear of them being taken on a line, though I have taken, and seen taken, in Sydney Harbour the so-called "black-perch" (*Girellæ simplex* and *tricuspidata*), but the mussel bait used had always to be "masked" with a piece of fine seaweed or *Zostera*. The peculiar "stripping" feeding habit they have, as described, is also common to the kanae (*Mugil perusii*, &c.) frequenting the same waters. I have known of as many as fifty dozen of

the parore captured in one haul of the long mullet-net, but the fishermen, generally without exception, throw them back into the water as soon as taken out of the net. It is a fish of very great vitality, living for some considerable time out of the water. Its flesh, though not rich, is very fair food.

Fam. SPARIDÆ.

Group CANTHARINA.

Genus GIRELLA.

Girella multilineata, sp. nov.

D., 15 + 1 simple + 11 branched (last ray double); P., 1 short spine + 1 simple + 11 branched + 3 feeble simple rays; V., 1 + 5; A., 3 spinous + 1 simple + 11 branched (last double); C., 16; B.R., 6, the first very short and feeble.

Head is to body and tail (total length) as 5 is to 22; head is to body (to base of caudal) a trifle more than as 1 is to 4.

Depth is to total length as $5\frac{1}{2}$ is to $17\frac{1}{3}$; depth is to body to base of caudal as 1 is to 3.

Scales: L.T. ($\frac{12}{20}$ to where they become buried in the epidermis when the lower part of belly is approached), $\frac{12}{25}$ dorsal-fin base to median line of ventral surface. L.L., 53. Small scales on extreme upper angle of operculum. None on sub-, pre-, or inter-opercula. A patch of small scales behind the eyes, and from thence extending down on to the lower part of cheeks. Nose, top of head, round top of eyes in front, and under eyes scaleless and soft-skinned.

Nostrils double, small, anterior, circular, with low surrounding skinny wall, slightly higher in posterior part. Posterior nostril oval, a little larger, no appendage. A low scaly sheath follows foot of posterior portion of spinal part of dorsal, and runs also partly along foot of branched portion. Branched rays of dorsal and anal comparatively slender.

The scales on the belly, from throat to anal orifice, are subcutaneous. Scales moderate in size on sides; small on back and belly. They are very tightly affixed, and scale-pockets nearly cover them, making scale-markings but indistinct when fish is first out of the water. They are of slight though tough texture and finely ctenoid. The scaling continues well on to base of caudal fin and membrane thereof, also on to base of anal.

Caudal fin is broad and large, slightly falcate at tips. Second and third spines of anal fin very strong, first much slighter. Dorsal spines stout and strong. Pectorals small, narrow, and rather slight, with slender rays; the three lowest

are simple, but short and very feeble. Ventral fin strong. Upper axillæ of pectorals provided with small, short, flat appendage.

Double row of broad, imbricate, tricuspid teeth along the edges of the upper and lower mandibles, behind which is a "trenched" toothless groove or space, and then the jaws are armed with short, small, flattened teeth in broad band, with points in three very fine cusps but little developed. The anterior edges of palatines, though not armed with distinct teeth, are developed into a certain amount of prominence and density, giving the approximation of a toothed edge. No canines, no teeth on vomer. Tongue very short, broad, and soft, and palatal curtain very pronounced.

Diameter of eye is contained nearly six times in length of head, also two and a half times in distance from posterior margin of preoperculum to extreme angle of gill-cover. The horizontal limb of preoperculum nearly same length as vertical, and they form almost a rectangle. Sub- and inter-opercula narrow. Projections of the principal frontal bones over the eyes are well padded with flesh, which, with a prominence of the bones below the eyes, causes a groove or depression running from the eye towards and under the nostrils. The cheeks and opercula are flattened.

The ninth and fifteenth rays of the spinous portion of dorsal are the highest, and length of either is contained exactly five times in the length of base of dorsal, or twice in basal length of anal. The rays gradually increase to this ninth ray, then decrease to the twelfth, then again increase to the last spine, which equals length of ninth. The first three rays of soft part of dorsal equal the length of the ninth or fifteenth rays of spinous. Extreme height of anal fin is much greater than dorsal, and slightly exceeds distance from posterior margin of orbit to extreme angle of gill-opening, or equals vertical depth of body under end of dorsal.

The height of pectorals is contained exactly three times in length of base of dorsal. The distance from snout to orbit is twice the diameter of eye (not orbit). The average breadth of larger scales is about one and three-quarter times the diameter of orbit. Top of head rounded between eyes and over nose. Distance between orbits about two and a quarter times diameter of orbit. Distance from anterior margin of orbit to tip of snout is a little more than one and three-quarter times the diameter of orbit. Distance from orbit to angle of jaws slightly exceeds one and a quarter times the diameter of orbit. Distance from upper angle of preoperculum to orbit equals diameter of orbit; from lower angle equals two diameters. Diameter of orbit contained three and one-fifth times in distance from anterior edge of orbit to extreme free angle

of gill-opening. Distance between eyes twice and a half in length of head. Diameter of orbit six times in length of head.

The jaws are feeble, mouth being capable of very little protrusion, dorsal terminates the longitudinal diameter of pupil of eye posterior to the vertical from termination of anal fin. Vertical of origin of anal a trifle in advance of the last spinous ray of dorsal. Ventrals commence in vertical with fourth spinous ray of dorsal.

The whole body is plump and robust, though the sides towards the tail-end are somewhat flattened, and the fish is a very full-blooded one.

Gill-rakers very fine and numerous. Gill-arches 4, with three long openings between first, second, and third, the opening behind the fourth being short, equalling in length diameter of orbit only.

The tricuspid teeth in the two rows in front of jaws are not recuperated from the row behind the groove. When destroyed they are renovated by new ones, which grow up from their bases again. The profile length of upper mandible about equals diameter of orbit.

The stomach is large and siphon-shaped; pyloric appendages very numerous, but none bi- or tri-fid. Peritoneum and lining of throat and mouth of a dense-black colour. Stomach filled with chewed remains of *Zostera* or some similar soft weed, and the intestines full of same digested. It may be remarked that the stomach and bowels of these fish are always excessively gorged with food and food remnants.

Colour: Cheeks and nose golden-green, also tail at base of caudal fin. Top of head and back olive-brown; sides greyish silvery, with pinkish reflections. Throat and belly white. Dorsal fin transparent brown, mottled on rays with darker, in extension of side-bars. Tail brown, tipped with darker, with rosy reflections. Pectorals transparent light-brown. Ventrals brownish, shading to white at axillæ. Anal clear brown, mottled and tipped with darker. Eye, dark golden-brown iris; pupil black, surrounded with golden margin. Lips light pinkish-brown. Eleven narrow rich dark-brown bars descend from the back, the series always commencing from beginning of dorsal and extending in a partially diagonal direction down back and sides; the tenth bar ends near termination of dorsal; the eleventh a proportionate distance from last bar in rear of dorsal. They are not quite symmetrically defined on each side of the body, as they originate from the alternate ray of dorsal from that which is the point of origination on the reverse side. The width covered by each bar roughly approximates to the vertical exposed breadth of a scale.

	In
Total length (inclusive of caudal)	19·2
Length to base of caudal	13·3
Greatest depth	5·1
Length of head	3·85
Greatest diameter of orbit	0·7
Greatest diameter of eye	0 65
Direct length base of dorsal fin	8·2
Direct length base of anal fin	3·3
Extreme height of pectoral	2·6
Extreme height of ventral	2·45
Heights of ninth and fifteenth dorsal spines	1·6
Greatest expanded width of caudal	6·4
Width narrowest part of body near tail	2·0

Art. XI.—*Formaline in Museology.*

By Dr. G. Thilenius, Lecturer on Anatomy to the University of Strasburg.

Communicated by Sir J. Hector.

[*Read before the Wellington Philosophical Society, 20th September, 1898.*]

The liquid called "formaline," or "formol," represents a 40-per-cent. solution of formaldehyde in distilled water, and is likely to replace spirits of wine in many cases, and to improve the conditions and general aspect of preserved specimens. On its introduction into museology formaline was used indiscriminately, and in the same way as spirits, the result, of course, being, to a certain extent, the discrediting of the liquid. By degrees the limits of its use, the proper concentration, and its drawbacks have been observed, and in the following lines I give a short notice of my six years' experience.

Vertebrates.

Mammals, birds, and reptiles ought to be preserved in spirits in the usual way. Formaline does not penetrate the skin sufficiently, and, even after opening the abdomen, it is not possible to get a satisfactory result. Especially if the specimen is intended for anatomical dissection formaline must be avoided, because it entirely prevents the maceration of the skeleton. The only exception to this rule is that of a rare small mammal or bird, which, being badly shot, or spoiled, has to be preserved, skinning not being possible. In this case, after opening the abdomen and removing the intestines—except ovaries and testicles—a ball of cotton soaked in con-

centrated formaline is to be placed in the cavity, a similar one filling the throat. In a few days the specimen will be mummified, and may be kept. In larger specimens—*e.g.*, pheasants—where the aorta is easily to be found, it is advisable to inject a quantity of concentrated formaline into the arteries before filling the abdomen with soaked cotton. This is to make sure of the preservation of the legs, arms, and head.

Large fish should be skinned or preserved in spirits after opening the abdomen, formaline being useful only for the smaller fish. The advantage of formaline lies in the preservation of the shape of the body and of the superficial slime covering the scales. Part of the colours, however, will fade away after a short time, as in spirits; the yellow, blue, pink, and violet adipochromes being soluble in formaline as well as in spirits.

The method for smaller fish is used, too, for Batrachia. The skin (epithelium) of both resists the penetration of formaline as strongly as that of a mammal or bird. The simple immersion of a fish in formaline will, of course, preserve the outside well, but the interior will, after some time, fall to pieces. To avoid this the specimens have to be injected. The solution used is 10 per cent. in fresh water; sea-water must be used for sea-fish. In each case the addition of 1 per cent. of kitchen salt will secure the specimen from looking swollen by the action of the formaline on the connective tissue. The said solution should be injected from the anus into the gut, from where it will slowly diffuse into the tissues of the body. In larger fish (8 in. and more), especially if they are of any depth—the distance from the abdominal cavity to the back fin exceeding 1 in. —after injecting the intestines a pointed cannula (hypodermic) is to be used in injecting the 10-per-cent. solution through the skin of the back into the muscles in several places. The same effect will be obtained by injecting the solution from the art. cœliaca. After the injection the specimens of Batrachia and fishes are to be kept in a 1–2-per-cent. solution of formaline, with about ½–1 per cent. of kitchen salt. Small fish (1–2 in.) may be preserved without injection.

Evertebrates.

In evertebrates it is to be borne in mind that formaline is apt to destroy the small calcareous corpuscula contained in the skin of various animals—*e.g.*, *Synaptæ*. Those, of course, are to be killed in the usual way—sea-water, with ether sulf.—and preserved in spirits. Spirits should be used for Crustacea and echinoderms, if they are not dried all together.

In insects it is often desirable to preserve gallæ, webs, cocoons, &c., containing eggs or small larvæ, together with

the branches, leaves, &c., upon which they are found. The easiest way is to put the whole branch or leaf into a glass tube or jar, and a few drops of concentrated formaline on the bottom of the glass, which will soon evaporate and preserve the object. The glass has to be kept air-tight and well closed. Cephalopoda are kept in a 2-per-cent. solution of formaline in sea-water, which has to be changed several times. It is advisable to inject a small quantity of the same solution into the siphon of the animal.

Shellfish, oysters, &c., are kept in the same way after opening the shells, or removing one of them entirely. To avoid the changing of the solution, the animal may as well be killed by pouring boiling water over it. After a few minutes the coagulation of the albumen will be finished, and the specimen may be mounted at once in the 2-per-cent. solution in sea-water. In the same way slugs and snails may be treated. To avoid the contraction of the body, before pouring out the boiling water they should be anæsthetized or killed in sea-water mixed with ether sulf. or cocaine. Generally the *Tunicata* may be preserved in the same way, if possible using living animals. This is indispensable with *Medusæ*, *Salpæ*, *Pyrosomæ*, &c. The best plan is to put them immediately from the net into a 10-per-cent. solution of formaline in sea-water. They die in a few seconds, and coming home you can select the specimens you require, which should be mounted in a fresh 10-per-cent. solution. *Siphonophoræ* have to be killed in another way, to avoid the dismembering. The animal is kept in as little sea-water as possible, in a much larger (higher) jar. Then a large quantity of a solution of cupr. sulf. (25 per cent.) is at once poured over it. After an hour or less the specimen may be placed in a 2-per-cent. solution of formaline in sea-water. Sea-worms, *Aphroditæ*, &c., do not keep in formaline. They are killed in a concentrated solution of corrosive sublimate, and after about ten minutes washed out in a weak solution of spirits of wine, and mounted in a spirit of about 80–90 per cent.

Specimens of any description which have been hardened and preserved in spirits of wine may, without inconvenience, be placed and kept in a 2-per-cent. solution of formaline, the mixture of spirits and formaline being of no consequence. Vertebrates, however, after a certain time will not be fit for dissection and maceration, while *Synaptæ*, etc., will have their calcareous formations destroyed.

Art. XII.—*On the Habits of* Dermestes vulpinus.

By A. T. Potter.

[*Read before the Auckland Institute, 20th June, 1898.*]

This is a very destructive beetle which I have had under observation for the last three years, having first noticed its larvæ in a building in Whangarei in December, 1895. Since then I have carefully noted its metamorphoses each season. This insect has been imported here, very likely in bones from Sydney. It is placed amongst occasional agricultural pests in England and America on account of its ravages—which are well known—on skins and hides. It is unnecessary to enter on these here; but its injuries to bones and wood seem much less known, and therefore a few remarks may be of interest.

The average size is about $\frac{3}{8}$ in. long. The shape is somewhat narrow and flattened. The general colour above brownish or greyish-black, with more or less very short pale fine hairs, and white pubescence on the head; a broad band along each side of the thorax or fore-body being much more thickly covered with longer and whiter hairs, so as to show clearly, like a long white or grey patch; beneath the abdomen quite white.

The beetle, I believe, will propagate on grease, or dirt of that nature, but only in very hot weather. The larvæ are very hairy, and in length average over $\frac{1}{2}$ in., and when about to change to the pupa state will burrow into the sound woodwork of a building, which in some cases is reduced to a honeycomb. The largest specimens noticed by me were a little over $\frac{5}{8}$ in. long by $\frac{3}{16}$ in. in diameter, subcylindrical, tapering gradually to the tail, more bluntly to the head; general appearance brown above, whitish below, excepting towards the hinder extremity, where the brown colour turns down, as it were, from the upper side, and extends beneath to the tail; a pale yellowish-brown line runs along the centre of the back above, and between each segment there is usually a yellowish line. Above the tail, which is bluntly pointed, are two somewhat thorn-like processes. Head dark-brownish, as also the six clawed legs.

The eggs are hatched in from four to seven days, and the newly hatched grubs, which at first were almost white, in a few hours took the ordinary colouring, and buried themselves in their food. After moulting several times, the full-grown grub formed a chamber in its food material, or in any other convenient locality at hand, when it curled itself up, loosely

covered with some of its own food and the refuse around it. There it lay for five days, then moulted again for the last time, and turned to the pupa (or chrysalis), from which the beetle developed in thirteen days.

The temperature I kept was about 70 deg.

ART. XIII.—*Notice of the Occurrence of the Australian Snipe* (Gallinago australis) *in New Zealand.*

By T. F. CHEESEMAN, F.L.S., F.Z.S.

[*Read before the Auckland Institute, 15th August, 1898.*]

THE distance separating Australia and New Zealand is so great that one might suppose it would present an almost insuperable barrier to the migration of birds, save perhaps for those species—as the albatros and its allies—whose home is on the ocean itself. But, notwithstanding the twelve hundred miles which intervene between the two countries, it is well known that there are certain birds—as, for instance, the shining cuckoo and the common godwit—which every spring appear in New Zealand, and every autumn return to Australia. And, in addition to these regular migrants, quite a number of Australian birds occasionally visit New Zealand. As instances I need only mention the Australian roller (*Eurystomus pacificus*), the Australian tree-swallow (*Petrochelidon nigricans*), the Australian swift (*Cypselus pacificus*), the black-faced shrike (*Graucalus melanops*), the masked plover (*Lobivanellus lobatus*), and the true curlew (*Numenius cyanops*). As to why it is that these species now and then stray so far from their proper home we have no certain knowledge, although we conjecture that in most cases it is probably due to the influence of storms. I have now to exhibit a specimen of the Australian snipe (*Gallinago australis*), being, as far as I am aware, the first obtained in this country. It was shot by Mr. C. C. Sandford on the 26th March of this year in a field near Arch Hill, on the western side of Auckland. Mr. Sandford recognised that it was a stranger, and was kind enough to bring it to the Museum at once, thus enabling me to have it properly preserved. Only one specimen was noticed.

The Australian snipe is very closely allied to the common snipe of Europe (*Gallinago cœlestis*), differing chiefly in the slightly larger size, somewhat different plumage, and in the

tail being composed of eighteen feathers instead of sixteen. It is found in all suitable localities in Australia and Tasmania, and northwards to Formosa and Japan, where it breeds.

Mr. Gould, in his "Handbook to the Birds of Australia" (vol. ii., p. 272), says, "In Tasmania it is very abundant during the months of October, November, December, and January, affords excellent sport to those fond of snipe-shooting, and is to be found in all low swampy grounds, lagoons, rivulets, and similar situations. Its weight varies from 5 oz. to 6½ oz.; it is consequently a much larger bird than the *Gallinago scolopacinus* of Europe. It flies much heavier than that species, and thus affords a more easy mark for the sportsman; it is also more tame, sits closer, and when flushed flies but a short distance before it again alights. On rising it utters the same call of 'scape-scape' as the *Gallinago scolopacinus*. It is said to breed in Tasmania, but, although many of the birds that I killed bore evident marks of youth, I could not satisfactorily ascertain that such was the case. I found it very abundant in many parts of New South Wales—in none more so than in the lagoons of the Upper Hunter—during the months of November and December; but it was only a transient visitor, the lagoons and swampy places then filled with water having attracted it."

The Australian snipe is at once distinguished from the snipes indigenous to the outlying islands of New Zealand—*G. pusilla*, *G. aucklandica*, *G. huegeli*, &c.—by its much larger size, darker plumage, and by the broad red band crossing the tail.

Before concluding, it may not be out of place to mention the extreme sensitiveness of the bill in the snipes generally, as described by Newton and other authors. A number of branching nerve-filaments run nearly to the tip, and open under the soft cuticle in a series of cells that give that portion of the bill almost the appearance of honeycomb, and which can be felt externally as roughened projections on drawing the finger down the bill. Thus the bill becomes a most delicate sense-organ, enabling the bird, when probing for its food, to distinguish at once the nature of the objects it encounters, although quite out of its sight. The same result is obtained by the kiwis, but in a somewhat different manner. In their case the nostrils, instead of occupying their usual position at the base of the bill, are placed almost at the very tip. In probing the ground the kiwis are consequently able to recognise their food by the sense of smell, whereas in the snipes the sense of touch is used.

ART. XIV.—*A Contribution to the Study of the* Rotifera *of New Zealand.*

By F. W. HILGENDORF, M.A.

[*Read before the Auckland Institute, 15th August, 1898.*]

Plates VIII.–XI.

TAIERI Beach is a small settlement on the south bank of the Taieri River, just at its mouth. There are a great number of small algæ-covered pools scattered over the district, but I found Rotifers in only four of these. One small pool of about 3 ft. by 4 ft. and 18 in. deep supplied thirteen out of the sixteen species to be mentioned in the course of this paper, while the next pool to it—about 200 yards away—was perfectly barren. Most of the varieties were found to be restricted in their distribution, each occurring in only one pool. The only species that was found to be distributed over a number of pools is that which is already noted for its cosmopolitan distribution—I mean *Rotifer macrurus*. A small Salpinidæan was also widely distributed. There were also several eccentricities in the time as well as the place of the Rotifers' appearances. A variety that would be most common at one time would totally disappear for weeks, and then would suddenly reappear in as great profusion as before. These points have, of course, been observed by every writer on Rotifers. Most of the species were lacustrine, but one was found in the water of a tidal creek, where the water was salt enough to be a habitation of marine Gasteropods, and to deposit quite large crystals of salt when it was evaporated.

The following are the only pools examined with any results, with the species found in them, the Roman numerals standing for the number of each species as described in this paper :—

1. A small pool: I., III., IV., VI., VII., VIII., IX., X., XI., XII., XIII., XIV., XV.
2. A horse-trough: II., V., IX., I.
3. Ditch in connection with tidal creek (saline): IX., XVI., I.

Thus sixteen species are described in this paper. Of these, four are found in Britain. The other twelve are new, and include representatives of two new genera.

The system of classification followed is that proposed by Ehrenberg and Dujardin, modified by Hudson and Gosse. This divides the class into the four orders—*Rhizota, Bdelloida, Ploima,* and *Scirtopoda.* Two Rhizotes have already been

described from New Zealand (*vide* Trans. N.Z. Inst., vol. xii., p. 301, and vol. xxv., p. 193), and my specimens include representatives of the *Ploima* and *Bdelloida*, so that only *Scirtopoda* remain to be discovered. This system of classification will be found fully described in Hudson and Gosse's "Rotifera," as well as (in its crude form) in the Journal M. Sci., xxiv., 335.

The following is Hudson's latest classification, reduced to tabular form:—

Order.	Characteristics.	Family.	Characteristics.
Rhizota ..	Fixed when adult. Foot wrinkled, non-retractile, non-furcate, and with a sucking-disc	Floscularidæ	Corona produced longitudinally into setigerous lobes; buccal orifice central; ciliary wreath a single half-circle above the buccal orifice. Trophi uncinate.
		Melicertidæ	Corona no setigerous lobes; buccal orifice lateral; ciliary wreath a marginal continuous curve, bent, and encircling corona twice; only one gap. Trophi malleoramate.
Bdelloida	Swim with ciliary wreath, and creep like a leech. Foot wholly retractile within the body, telescopic, furcate	Phillodinidæ	Corona two transverse circular lobes; ciliary wreath marginal continuous curve encircling corona twice; two gaps. Trophi ramate.
		Adinetadæ	Corona flat prone surface; ciliary wreath, furred ventral surface of corona. Trophi ramate; frontal column soldered to dorsal surface, and ending in two hooks.
Ploima ..	Swimming with their ciliary wreath, and in some cases creeping with toes	Micrococcidæ	Corona obliquely transverse, flat, circular; buccal orifice central; ciliary wreath a marginal continuous curve, and two curves of larger cilia one on each side of buccal orifice. Trophi forcipate. Foot stylate.
Sub-order Il-loricata	Integument flexible; no stiffened shell. Foot absent, furcate (usually), not wrinkled; feebly telescopic, and partially retractile	Asplanchnidæ	Corona subconical, with one or two apices; ciliary wreath single, edging corona; intestine and cloaca absent.
		Synchætadæ	Corona a transverse spheroidal segment, sometimes much flattened, with styligerous prominences; ciliary wreath a continuous or interrupted marginal curve encircling corona; mastax very large, pear-shaped. Trophi forcipate. Foot minute, furcate.

Order.	Characteristics.	Family.	Characteristics.
Sub-order Il-loricata —*contd.*	..	Triarthradæ	Body furnished with skipping appendages; corona transverse; ciliary wreath single, marginal. Foot absent.
		Hydatinadæ	Corona truncate, with styligerous prominences; ciliary wreath two parallel curves, one fringing corona, the other within it, prominences between the two. Trophi malleate. Foot furcate.
		Notommatadæ	Corona obliquely transverse; ciliary wreath of interrupted curves and clusters, usually with a marginal wreath surrounding the buccal orifice. Trophi forcipate. Foot furcate.
Sub-order Loricata	Integument stiffened into a wholly or partially enclosing shell. Foot various	Rattulidæ	Body cylindric or fusiform, smooth, without plicæ or angles; contained in a lorica closed all round, but open at each end. Trophi long, asymmetric. Eye single, cervical.
		Dinocharidæ	Lorica entire, vase-shaped or depressed, sometimes facetted, often spinous; head distinct, with chitinous covering. Foot and toes often greatly developed. Trophi symmetrical.
		Salpinidæ	Body more or less completely enclosed in a firm lorica, which is open at each or only one end, and divided down the back by a fissure, whose sides are united by membrane. Two furcate toes always exposed.
		Euchlanidæ	Lorica of two dissimilar plates, one dorsal or ventral, united so as to form two confluent cavities, of which the upper is much the larger. Foot jointed, furcate.
		Cathypnadæ	Body enclosed in a lorica, open at each end, of two plates, the dorsal more or less elevated, the ventral nearly flat, the two divided by a deep lateral longitudinal sulcus, covered with flexible membrane. Toes two or one, always exposed.

Order.	Characteristics.	Family.	Characteristics.
Sub-order Loricata —*contd.*	..	Coluridæ ..	Body enclosed in a lorica usually of firm consistence, variously compressed or depressed, open at both ends, closed dorsally, usually open ventrally. Head with chitin hood. Toes two, rarely one, always exposed.
		Pterodinadæ	Lorica entire, various; corona and wreath those of *Philodinidæ*. Trophi malleo-rama. Foot wholly retractile, transversely wrinkled, jointless, toeless, ending in a ciliated cup, or foot absent.
		Brachionidæ	Lorica box-like, open at each end, generally armed with anterior and posterior spines. Foot long, excessively flexible, wholly retractile, wrinkled, and two-toed.
		Anuræadæ	Lorica box-like, broadly open in front, behind open by only a narrow slit; usually armed with setæ. Foot wholly wanting.
Scirtopoda	..	Pedalionidæ	Arthropodous limbs six; corona of two concave lobes; ciliary wreaths as in *Philodinidæ*. Trophi malleo-rame

The different types of trophi are referred to under the names given to them by Hudson. He presumes the typical form of mastax to be that found in *Brachionus urceolaris* (Journal Mic. Sci., xxiv., 350). There are two hammer-like bodies (mallei) (*c*, *d*), which work on a split anvil (incus) (*e*, *f*). Each malleus consists of an upper part, or head (uncus) (*d*), and a lower part, or handle (manubrium) (*c*). The incus also consists of two parts, the upper divided into two symmetrical halves (rami) (*e*), which are supported on a lower piece (fulcrum) (*f*). There the mallei are prominent, but all the other types of trophi are marked by successive degradations of the mallei and increase of the incus. The following are the seven chief types of trophi :—

1. *Malleate.*—Mallei stout; manubria and unci of equal lengh; unci 5- to 7-toothed; fulcrum short. (*Brachionus.*)

2. *Sub-malleate.*—Mallei slender; manubria about twice as long as unci; unci 3- to 5-toothed. (*Euchlanis.*)

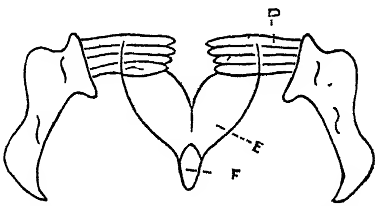
3. *Virgate.*—Mallei rod-like; manubria and fulcrum very long; unci 1- or 2-toothed. (*Notommata.*) A common type.

4. *Forcipate.*—Mallei root-like; unci pointed or evanescent; rami much developed, and used as forceps. (*Diglena.*) Another common type.

5. *Incudate.*—Rami highly developed into a curved forceps; mallei evanescent; fulcrum stout. (*Asplanchna.*)

6. *Uncinate.*—Unci 2-toothed; manubria evanescent; incus slender. (*Stephanoceros.*)

7. *Ramate.*—Rami subquadratic, each crossed by 2, 3, or 4 teeth; manubria evanescent; fulcrum vestigial. (*Philodina.*)



Trophi of *Brachionus urceolaris*: *c*, *d* = malleus, *e*, *f* = incus, *d* = uncus, *c* = manubrium, *e* = rami, *f* = fulcrum.

The following is the order observed in the description of each species: Specific characteristics; length; colour; general shape; special shape and proportions of body, foot and toes, and head; corona and ciliary wreath; lorica; mouth and gullet; mastax; the other parts of the alimentary canal; musculature; glands; brain and sense-organs; excretory system; reproductive system; movements, habit, and habitat.

Order BDELLOIDA.

Family PHILLODINIDÆ.

Genus **Rotifer.**

Generic characteristics: Eyes two, within the frontal column.

I. *Rotifer macrurus*, Schrank. Plate VIII., figs. i., i.*a.*

Specific characters: Body white, hyaline at ends, plump and round, merging rather gradually into a very long and tapering foot. Corona large. Spurs small. Frontal column long, cylindrical, truncate. Dorsal antenna of moderate length. Eyes small and round. Teeth two. Differs from English

* Having reason to believe that some of my measurements of length were not quite accurate, I have left this detail out of all my descriptions, awaiting more accurate observation.

variety in—(1) Less plumpness of body; (2) less difference in circumference of body and foot; and (3) greater transparency of body.

No colour. The whole Rotifer is very long and slender. The body proper is less than a third of the length of the whole animal. It shows the plumpness referred to in the British specimens in only a slight degree. It is ornamented with longitudinal flutings of various distinctness, but these are never obtrusive, and have always to be looked for. The foot is very long, slender, and tapering; it consists of six telescopic joints, and is perfectly retractile; the second last joint bears a pair of spurs whose tips are slightly curved. There are three very small toes, which are usually hidden by the spurs of the penultimate joint. The anterior part of the body—the neck and head, if I may so speak—is also long and slender, and very much pointed when fully extended. In this condition the cilia seem to be confined to a small narrow projecting lobe, but when the Rotifer is about to feed the anterior part of the head is completely retracted, and the corona and ciliary wreath spread out into two broad wing-like lobes, making the wreath a sinuous curve right round them, and broken only ventrally opposite the mouth. The mouth leads back by a narrow gullet (in which is a pair of kidney-shaped glands) to the pharynx, which is provided with a pair of ramate trophi. These are shaped like angular coffee-beans, and work upon each other somewhat after the manner of a crayfish's mandibles. There are on each a great number of teeth, in the form of transverse ridges; of these, the two central are by far the most prominent. The two trophi are not quite parallel, but diverge slightly behind. The stomach and intestine lead to the cloaca, which is a rectal, excretory, and reproductive chamber. Rather indistinct bands of muscles work the retractive movements of the foot, but the other muscles could in no case be seen. I did not observe any foot-glands; probably these are of less importance here than usual, because of the mechanical contrivance to secure the toe-hold. The three toes are spread out and placed on the glass, and then the second last joint is pulled down over them, and acts like a ferrule. Obviously the strength and quantity of the cement secreted by the foot-glands need not be so great here as if the whole weight of the animal were to be supported by that alone. I never observed any brain. There are two small red eyes. These lie right in the anterior of the head, and, when this region is protruded, appear to lie quite in the anterior lobe of the corona. They move back very considerably when the corona is expanded in the act of feeding.

In the dorsal side of the "neck," just anterior to the body,

is a dorsal sense-organ; it is of good size, bears a tuft of setæ, and is capable of being erected and depressed.

Rotifer macrurus is viviparous. In examining a specimen I was greatly puzzled by the appearance of two small faint eyes away back in the posterior part of the body, and also by the appearance of two small trophi, which moved slightly while I was watching them. It was not for a long time that I discovered that these appearances were due to the presence of a young Rotifer with the body of its parent. The fœtus was bent round upon itself, and moved freely within the space at its disposal. It turned completely round several times, now having its head directed forwards, and now backwards. It was perhaps half as long as its parent, but much more slender even proportionately.

Movement, typically Bdelloidan. The hold with the foot is taken quite beside the hold with the head, so that the Rotifer travels fully its own length at every loop. I never saw it swim with its ciliary wreath. Its motions were usually lively, a period of creeping being alternated with one of feeding; but at times it would lie wholly retracted into an almost spherical ball. This was the usual attitude taken when death was approaching, but one specimen remained fully extended, and curled its foot up, just as a pig's tail is curled.

Hab. Among Algæ allied to *Spirogyra*. In small pools. Fairly plentiful.

Genus **Callidina**, Ehrenberg.

Generic characters: Eyes absent.

II. *Callidina quadridens*, sp. nov. Plate VIII., figs. ii., ii.*a*.

Specific characters: Body plump and fluted distinctly, but not closely. Foot very slender. Ciliary wreath projecting forward in two sharp prominences. Teeth, 4.

No colour. Its general shape is long and slender, more so than *R. macrurus*. Its body, however, shows some plumpness as compared with its long head and foot. This latter is very slender, and contains about six telescopic joints. The head is very long, the neck part of it being transversely wrinkled. It is when the anterior part of the head is retracted and the corona expanded that one of the differences between this species and other Callidinas is seen. Instead of the corona consisting of two broad lobes, lined by a sinuous wreath of cilia, there are two very narrow projecting lobes, very much narrower than the rest of the body. The longitudinal flutings of the body were very distinctly marked. The mouth is in the ventral centre of the corona. Just within it, on each side of the gullet, are two very distinct bean-shaped glands. These

were observed only once in *R. macrurus*, and then they were very indistinct. Far back, within the contour of the body, are the trophi. These are of the same shape as those of *R. macrurus*, but instead of having only two they have four distinctly marked transverse ridges. The stomach is very capacious. No brain was observed; neither was any kind of sense-organ. The eyes and the dorsal organ are entirely wanting.

Movement, quite like that of other Phillodinidans.

Hab. The horse-trough.

I found only one specimen of this species, and so my description is lamentably incomplete; but there is no doubt that it is a species quite distinct from *C. bidens*, which in general aspect it somewhat resembles.

Order PLOIMA.

Sub-order IL-LORICATA.

Family Hydatinadæ.

Genus **Hydatina**, Ehrenberg.

Generic characteristics: Body conical, tapering towards the foot. Foot short, and confluent with the trunk. Eye absent, or one cervical.

The distinctive characters of this genus have been enlarged by me, so as to admit a specimen clearly very closely allied to *H. senta*, but possessing a large complex and beautiful eye.

III. *Hydatina monops*, sp. nov. Plate VIII., fig. iii.

Specific characters: Brain large, dark, and very noticeable. It is composed of two large lateral lobes and a smaller posterior one, which is balanced in front by a large red eye.

One of the three largest Rotifers I have seen, equalling *Planoventer gigans* and *Notommata pentophthalma*. There is no definite colour excepting that of the eye, but the usual transparency is absent here, owing partly to its great bulk, and also, no doubt, to a greyish tinge in the organs themselves. The whole animal is pisciform, although it does not taper towards the head. The body is cylindrical, and tapers posteriorly to the thick short foot, which ends in the two small toes. The head is marked off from the body by a deep indented line or neck; it leaves the head about one-third the length of the body, and almost as great in circumference. The head is truncated in front, so that the corona is transverse. The cilia are disposed in a single row, fringing the head of the corona, but breaking opposite the mouth. The cilia at the sides of the head are very large. Several large tufts of cilia

occur on the corona, within the encircling wreath, and just outside an inner wreath. Most of these are so disposed as to very effectually assist the passage of the food to the mouth. Owing to the opaqueness of the surrounding parts, neither mouth, gullet, nor mastax was accurately observed. The mastax is probably very small, and situated about half-way back in the head, for this is where the brain is situated, and it is the only organ of sufficient density to hide so usually obtrusive an organ as the mastax. Behind the mastax the stomach swells out suddenly, and then tapers gradually to the intestine, closely following the outline of the whole animal. The intestine is narrow, and opens into a very small cloaca. There are many strong and obtrusive muscle-bands; those in the head and anterior part of the body pass outwards and backwards, those in the posterior parts more or less parallel with the body-walls. The foot-glands were very noticeable; they are of large size, dark colour, and Indian-club shape; they are quite distinct, and each enters its own toe quite separately. The brain is of quite enormous size. As before hinted, it lies about the centre of the head, and is probably roughly spherical. Looked at from above it is composed of three lobes, two large lateral ones and a small posterior one. It is heavily loaded with a black pigment. In front, corresponding with the small posterior lobe, is inserted a large red eye-spot of rather complicated shape, rather like that of a fancy vase with a knobbed lid on, but clearly seen in the accompanying figure. The bladder for the reception of the excreta is unusually large. It lies to the left and ventral side of the posterior part of the stomach and the intestine, and passes by a narrow tube back to the small cloaca, which opens some distance in front of the foot. Floating all about in the body-cavity were numbers of large eggs; these were already highly segmented in some cases, while in others segmentation had not as yet commenced. The ovary itself, which was very obscure, appeared to lie in the right ventral part of the body-cavity.

Movements and habits I cannot describe, as my only specimen was almost dead when I found it.

Hab. The horse-trough.

Family NOTOMMATADÆ.

Genus **Notommata**, Gosse.

Generic characteristics: Body not annulose, more or less cylindrical, in my species a good deal depressed. Special organs on the head for locomotion; auricles, evertile and protrusible. Brain large, containing opaque chalk masses. Trophi virgate. Eyes (see "Specific characters," below).

IV. *Notommata pentophthalma*, sp. nov. Plate IX., fig. iv.

Specific characters: Body flattened and enclosed in a more or less firm leathery sheath, almost like a lorica, leading to a deceptive similarity between this species and a Euchlanidæan. Trophi very large, in middle of the body. Eyes five, one in the anterior of the large dark cervical brain, and two pairs of frontal ones, a large inner and a small outer pair. Tail short. Foot long and prominent. Toes of fair size.

Although this species has five definite eyes, and although no other *Notommata* has more than one, and the *Eosphora* have three, yet I have decided to call this a species of *Notommata*, because of the instability of the number of eyes all through this family, and its consequent worthlessness as a generic characteristic. For instance, Herr Eckstein (Sieb. w. Köll. Zeits., 1883, p. 361) describes in *Notommata aurita*, and in many other Rotifers, specks of crimson pigment frontally situated. These he concludes to be secondary eyes. Again, in *N. naias* Eckstein figures two crimson frontal eye-specks, as he also does in *N. lacinulata* and *Proales felis*. All these Hudson has no hesitation in pronouncing imaginary ("Rotifera," ii., 37). Again, Hudson himself credits *Eosphora aurita* with three eyes, but two of them are denied by Leydig. In this state of affairs the eye-spots cannot be of great value as a distinguishing character, but the discovery of my five-eyed species may make Eckstein's "imaginary" eye-spots worth reconsidering. There can be no doubt about the objectivity of the five eye-spots in my species, for I examined between twenty and thirty specimens, and they were invariably present.

The biggest Rotifer I have seen. No colour except the five red eye-spots, situated as hereinafter described. The body is depressed, but raised up above the head and foot so as to make itself very sharply divided off from them, and also to give itself the appearance of bearing a lorica. The part raised above the foot is the tail. The body is slightly longer than broad, and has an outline consisting of many rough curves, which are constant in position, and show that the integument is hardened in the body region. The foot is of good length, about one-third as long as the body; it projects from under the hardened body-integument, ending in the tail, and is terminated by two small toes. The head is of great size, nearly half the bulk of the body. Near the front of it are two most distinct and highly evertible auricles, cilia beset. These are usually withdrawn, but when protruded are most striking. The whole of the front edge of the head is provided with cilia. The mastax is of great size, and is of the complicated forcipate type. The extreme breadth of the

trophi is noticeable, as is also their peculiar position, right back in nearly the middle of the body. The stomach and intestine are consequently very short, though in one case it appeared as if the stomach swelled out around and ran forward from the mastax. The most important muscles are those which work the mastax. These are of great size and density, and work against each other. Immediately in front of the mastax is the brain; it is of fair size, dark, granular, and opaque; it is semicircular in shape, the diameter of the circle facing forwards. Let into this forward-facing side is a small semicircular eye, concentric with the brain. This is the largest of the eyes, of which there are in all five. The other four are arranged in two pairs very near the front of the head. There is one pair of larger ones, and slightly outwards and forwards from these another pair of much smaller ones. Running forward from the cerebral eye is a double row of bright round spots, about twelve in number, and reaching to the anterior extremity of the body. I cannot guess their use, though it is probably sensory.

The movements of this Rotifer are very slow. The trophi sometimes work actively, opening very widely from side to side. One specimen had retracted its head and foot (an operation not frequently performed), and so appeared quite round. It was filled with small green bodies, probably devoured *Protozoa*.

Hab. The pool.

Five or six specimens were observed during the winter.

Genus **Planoventer**, gen. nov.

Generic characteristics: Of great size, never less than $\frac{1}{80}$ in. Body flattened ventrally, arched dorsally Corona almost quite prone, with only a slightly upward inclination. Foot very indistinct; toes of fair size. Brain large and dark-coloured. Eye distinct, cervical in position, just in the anterior part of the brain. Tail and auricles wanting.

I have tried to put this specimen into nearly every genus of the *Notommatadæ*. The absence of tail and auricles, and the presence of an eye, close to it all genera but *Proales* and *Furcularia*. Now, all the *Proales* hitherto described are small and slight, not large and massive; the ciliated face is not nearly prone, and the brain is invariably clear. As for the *Furcularia*, the body is larviform, not pisciform, compressed, not depressed, and the eye when present is always frontal, not cervical. For these reasons I have placed this specimen in a new genus rather than destroy the distinctness of an old genus by forcing an intruder within its ranks.

V. *Planoventer varicolor*, sp. nov. Plate IX., figs. v., v.*a.*, v.*b.*

Specific characters: There is no need of these till more species are placed in this new genus. The specific name chosen is given because the various colours are both very obtrusive and unlikely to be found in any species that may be afterwards discovered.

This Rotifer is very prettily coloured. The ovary, which is large and prominent, is of a deep salmon-colour, and the general colour of the body is a light-salmon. The walls of the stomach and intestines are remarkably thick, and are of a bright-yellow colour. The eye is of a brilliant red, and the brain also is tinged with a dark crimson-lake. The stomach is usually filled with a medley of green and yellow and brown food-matter, so that altogether the Rotifer is a very attractive and beautiful object, only the two extremities being without colour. In general shape it is fish-like, its greatest diameter being just anterior to the middle of the body, and tapering to both head and tail. The foot is very small, being chiefly composed of two fair-sized toes. The head is not distinctly marked off from the body. The corona is prone, hardly at all encroaching on the anterior pointed part of the head. The mouth, too, is ventral in the centre of the corona The gullet passes upwards and backwards. The trophi are very close to the mouth, and they are often extruded therefrom with a remarkably active snapping movement, so that, as Hudson says, it is difficult to believe that you do not hear them close on each other. They are of the forcipate type of trophi, quite similar to those of the *Salpinidæ* and Furcularians. The stomach is capacious, and fills the middle third of the body. It narrows to the intestine, which opens dorsally just in front of the foot. The walls of both these parts are very thick, yellow in colour, and marked all through with black dots. Possibly these thickened walls may have some physiological significance. I noticed no particulár muscles, except the pad surrounding the mastax. The brain is large, depressed, and of oblong shape. It is situated dorsally, just at the junction of what may be called head and body. It is of dark-red colour. Immediately above it is a pit in the integument reaching down to the brain, and leaving only the thickness of the integument between it and the outer air. I have never seen a pit of this kind in any other Rotifer, nor have I ever seen it referred to by any writer on this subject. The eye is of a brilliant-red colour, and is probably just the pigmented anterior face of the brain. This is very frequently the case (*cf.* species III., V., IX. *intra*). The two foot-glands are large, and very prominent. The ovary is large, and of a deep salmon-colour; it lies ventrally, and to

the right side of the animal, and extends through nearly a third of its length.

Planoventer varicolor moves by swimming with its ciliary wreath. Its motions are slow, deliberate, and steady. It never retracts any part of its body, and so affords great facilities for observation. The extrusion of its jaws has been mentioned. This is not an uncommon movement. On one occasion I saw it put out its jaws and seize the end of a piece of Alga, draw it into its mouth, then shift its hold with the trophi, and draw it still further into its mouth, and so on until the piece of Alga stretched unbroken through the whole length of the stomach. Then it was cut off by the ever-active jaws.

Hab. The pool.

Sometimes common, and again not seen for weeks.

Sub-order LORICATA.

Family RATTULIDÆ.

Genus **Mastigocerca,** Ehrenberg.

Generic characteristics: Body fusiform, or irregularly thick. Toe a single style, with accessory stylets at its base. Lorica often furnished with a thin dorsal ridge.

VI. *Mastigocerca flectocaudatus*, sp. nov. Plate VIII., fig. vi.

Specific characters: Body compressed, flat ventrally, arched dorsally, and bent down anteriorly. There is no dorsal ridge. There is a long toe, nearly as long as the body, and a single long substyle, two-thirds as long as the toe. Cervical eye.

No colour except what is caused by highly refractive brown cells in the walls of the stomach. This Rotifer almost invariably swims on its side, and so a side view is by far the most familiar. It is more than three times as long as it is high, and the outline of the body is made up of long curves. The height is probably greater than the breadth, since the usual position in swimming under the cover-glass is on the side. This fact, however, may be explained by the bend in the foot, to be described now. The foot proper is very short and indistinct, but bears a very long style and a shorter substyle, which are bent downwards, and which are incapable of being straightened; moreover, they are set in the foot with a downward inclination, and so always have a general direction at about right angles to the body. This fact would account for the Rotifer not swimming on its ventral surface when under the pressure of the glass. The style is more than two-thirds as long as the body and head of the Rotifer, while the substyle is two-thirds as long as the main style. The foot is often bent so that the tip of the style touches the anterior

part of the body. The head is not distinctly marked off from the rest of the body; it is bent downwards, so that the corona is inclined at an angle of 45° to the plane of the rest of the body. The lorica is very poorly developed, and seems to be more or less pliable. It becomes very soft indeed in the posterior region of the body, but is a little stronger in front, where it forms a small spine on each side. This spine has a much smaller spine just below it. The trophi are of the abnormal forcipate type, and show the want of symmetry characteristic of the family. The left malleus is very long, but the right one is greatly reduced, both in thickness and length. The stomach is surrounded by a number of brown highly refractive bodies, which seem like glands. No brain was observed. The eye is small and round; it is situated above the anterior part of the mastax, and is well back within the body, being very far behind the anterior border of the lorica, which may be said to mark the head from the body. The ovary is small, and is situated posterior to and below the stomach.

This Rotifer's movements are active and restless. It almost always swims on its side—at least, when on a glass slide. Its jaws worked only very rarely. Occasionally it anchored by the tip of its style, held this rigid, and waved itself about from the joint at its foot.

Hab. The pool.

Very common in autumn.

VII. *Mastigocerca rectocaudatus*, sp. nov. Plate IX., figs. vii., vii.*a*.

Specific characters: Body a long oval, no ridge on lorica. Toe exactly straight, and slightly longer than the body and head. Substyles 4, minute.

No colour except the small red eye. Seen from the side this is a slightly hump-backed Rotifer, with the highest point in the middle; it is also broadest in the middle, and tapers towards the extremities, more so towards the posterior one of course. A symmetrical and rather graceful Rotifer. The foot is short and rather indistinct, but it has an immensely long style, quite as long as the rest of the body. This, as in *M. flectocaudatus*, is always carried at an angle to the general direction of the body. It is surrounded by three or four minute substyles. The head projects forwards and downwards from the body. The cilia must be very small, for I never saw them. The lorica is soft and flexible, though more developed than in *M. flectocaudatus*. There is a small median dorsal cleft, and the hinder border over the foot is concave. The mastax is of the asymmetrical type. The length and strength of the right malleus are very much

reduced, and the right side of the split ramus is also reduced in size. The stomach is plainly marked off from the rest of the alimentary canal, is of large size, and situated rather on the right side of the body. The intestine passes backwards and opens into the cloaca. just anterior to the joint between the foot and the body. No foot-glands were observed, though doubtless they occur, since the Rotifer frequently anchors itself by the extremity of its style. The small red eye-spot is situated well within the anterior border of the lorica. When the head is retracted the trophi move back into the middle of the body, and the eye moves back too, as if it were fastened to the muscles surrounding the mastax. The eye is situated deep down in the body; it is concave on its anterior face, as if it were the posterior border of a transparent globule, which is probably a refractive lens. I was able to make out no more of the internal organs, owing to the unusual opacity of this Rotifer.

The movements of *M. rectocaudatus* are swift and erratic. It seems at times to go into a dormant condition, and does not move for hours. It usually swims on its side, but sometimes its back is presented to the observer. The head is then almost hidden, owing to its downward flexure. The head is often retracted wholly within the body; then the median anterior cleft in the lorica is very clearly seen, and the mastax moves back into the middle of the body. When the Rotifer anchors by its style it waves itself about at the foot-joint, just as *M. flectocaudatus* does.

Hab. The small pool, and another one near it.

FAMILY DINOCHARIDÆ.

Genus **Dinocharis,** Ehrenberg.

Generic characteristics: Lorica vase-shaped, dense, pitted, facetted, and with projecting plates, or armed dorsally with spines. Head retractile within a chitinous cap. Eye single, apparently attached to the mastax. Foot and toes very long, the former bearing spines.

VIII. *Dinocharis inornata,* sp. nov. Plate IX., fig. viii.

Specific characters: Lorica neither facetted nor armed with dorsal spines, but pitted. There are no transverse ridges, but the lorica is smooth. The cap covering the head and the chitinous covering of the foot are not pitted, although the latter bears spines.

The only specimen of this species had about one-third of the way back in its body a large black blotch, which was probably due to some food-matter. There were also some brown cells, probably in connection with the stomach. The general colour of the body was the lightest grey, just re-

deemed from transparency, but the little pits in the lorica make this last easily seen, because of the shadows thrown in its substance. In general shape the body is a very long cylinder. The head, which is about half as long as the body proper, is also cylindrical, and is bluntly pointed. The foot is as long as the body; it is rather slender, and is marked with three telescopic joints. From the last joint spring the two immensely long toes, which themselves are as long as the body, and with the foot proper make up more than half of the entire length of the Rotifer. The cilia in the wreath are restricted in area, but they are very long, distinct, and powerful. The lorica is, next to the foot, the most striking feature of all, as, indeed, might be expected in a Dinocharidan. Where it covers the body it is strong and roughly cylindrical; it ends definitely at both anterior and posterior borders; it is slightly cleft below at the posterior edge; on its upper side, near its posterior end, is a characteristic hump. The lorica is not facetted nor spined, and in this differs from all other species of this family. In place of the facets are little pit-like indentations thickly scattered all over the surface. The head is either covered by an arched retractile chitinous plate or else quite surrounded by a cylindrical shield; I am not sure on this point. Only the posterior two-thirds of the head is thus covered. The proximal part of the foot is also covered with a shield, which is open below, and ends distally and dorsally in two spines, small when compared with those of the rest of the genus. This shield extends nearly half-way down the foot. The head- and foot-shields are not pitted as the lorica is, but have instead some very faint scratch-like markings. The trophi are small, weak, and simple, probably of the forcipate type. I can say nothing definite about the other internal organs, except that there is a small red conical eye, with its apex pointing backwards, just in front of the mastax.

The movements of this Rotifer are rather slow and deliberate. The head and foot, with their chitinous coverings, are frequently retracted. The habit of anchoring by the tips of the toes, and swinging about from side to side, is found here, as in so many other Rotifers.

Hab. The pool.

Rare.

Family Salpinidæ.

Genus **Diaschiza**, Gosse.

Generic characteristics: Body compressed, the dorsal half of the trunk enclosed in a carapace (more or less closed below), which is split medially. One eye present, usually cervical. Trophi virgate, not distinguishable from those of *Furcularia*. Toes long, blade-like, furcate.

IX. *Diaschiza taurocephalus*, sp. nov. Plate X., figs. ix., ix.*a*., ix.*b*., ix.*c*., ix.*d*.

Specific characters: Small, but not so minute as *D. exigua*. The lorica is firm, and apparently closed below. The head is very large. Foot prominent; toes about a quarter the length of the body. The lorica slopes away from its upper posterior edge to about the middle of the ventral line.

No colour, except for the small red globular cervical eye. In some, too, deep rich-brown cells are found surrounding the stomach. This Rotifer is of a short stout build, which is very characteristic. The body is hardly longer than it is high, and the lorica ends abruptly, giving a peculiar hump-backed appearance. The proximal part of the foot is very stout, and is terminated by two long toes. The foot and toes are carried more or less pendent, usually markedly so. The head is, but for the absence of sharp corners, almost an exact square, and is more than half the size of the body; it is marked off from the body by a shallow furrow. The cilia, which are rather short and thick-set, fringe the lower half of the front and the forward half of the bottom of the head. The lorica starts behind the head, and has a well-marked deep dorsal cleft; it is deepest and broadest behind, sloping upwards to non-existence in front. The mastax is of the forcipate type, and is fairly large and strong; it is surrounded by a dense and strong pad of muscle. The stomach and intestine are large, and situated dorsally. As mentioned above, the stomach is sometimes surrounded by large unicellular glands, probably digestive. The food in the stomach is often of a light-yellow colour; I have never seen the green or brown food-matter so commonly found. A few indistinct foot-muscles and the dense mass of muscles surrounding the mastax are all that are easily observed. The foot-glands are apparently large, but are indistinct, and evidently but little used, as I do not remember one of the scores of specimens I observed anchoring itself by its toes. The presumably digestive glands have already been twice mentioned; they are similar to those found in *Metopidia flexocaudatus*, but are not invariably present. The eye is of small size; it is situated near the dorsal surface, just at the junction of neck and body. There is a nick in its median anterior edge. No brain was observed. There is a large reproductive organ in the ventral part of the body.

This Rotifer is of very lively habits. It swims mostly on its side at a great rate across the stage. It is the most plentiful of all Rotifers at the Taieri Beach, and was found in every pool searched.

Var. *tenua*. Figs. ix.*c*., ix.*d*.

Varietal characters: Head small, and whole body slender. Foot stout; toes long. Distinct oblique furrow in the lorica, running forwards and downwards from posterior edge.

Colour, none except the deep-red cervical eye, and sometimes the brown cells round the stomach. In general shape this variety is quite unlike the type, so different that I long regarded them as distinct species. It is slender, and has not the least sign of being bull-headed. The foot is stout, and the toes very long. The toes are often spread out so that they lie in one and the same straight line. The head is slender, is not marked off from the body except by the edge of the lorica, and has a downward flexure. The ciliary wreath is much as in the type. The lorica encloses the body more completely than in *taurocephalus* itself. Its posterior edge is distinct, and does not slope away forward, as it does in the type. There is also a very distinct oblique furrow running from the posterior dorsal edge downwards and forwards to near the ventral anterior edge. The mastax is quite like that of the former variety, but is a little stouter. The other parts of the alimentary canal, the muscular bands, glands, excretory and reproductive systems, do not call for remark. The eye is small, but has behind it a small brain of a very light-pink tint.

This variety is on first appearance quite like *D. pæta*. The general shape and the oblique lateral furrow lend themselves to this impression. But the character of the eye is quite different, and this variety is connected by such an unbroken chain of slightly varying individuals with *D. taurocephalus* that there can be no doubt that the difference between them is only varietal. I have described the two extremes of this chain under the name of *taurocephalus* and *tenua*, but all intermediate stages are common.

X.—*Diaschiza semiaperta*, Gosse. Plate X., figs. x. x.*a*.

Specific characters: Body compressed, highest behind. Lorica with the dorsal cleft closed in front, gaping behind, the ventral edges apparently approximate. Eye frontal. Toes long, slender, recurved.

Colour, none except the small red eye. The shape is high, narrow, and rather clumsy. The body has a hump-backed appearance, the highest point being behind the middle of its length. The body narrows abruptly into a short stump-like one-jointed foot, ending in two extremely long and strong toes, half as long as the body. The head, which is marked off from the body only by its being not enclosed by the lorica, has a downward flexure, and its anterior edge is quite oblique. This oblique surface bears the cilia, and in its centre is a little

hemispherical projection, also cilia-covered, and also bearing the small red eye. This little ciliated and eye-bearing lobe constitutes the chief difference between my variety and that described by English writers, but it is not enough to need the formation of a varietal name. The lorica is vase-shaped and entire, but for its dorsal cleft, which is not complete, occurring only posteriorly, and so exactly corresponding with the English *semiaperta*. The mastax is of the highly developed forcipate variety, though I can hardly vouch for the details of my figure. It is situated far forward, completely within the head. The other parts of the alimentary canal were quite obscure, the only thing noticed being that they occupied the usual dorsal position. No particular muscles, glands, or brain were noticed. The peculiar position of the eye, on a lobe apparently its own, and further forward than in any other variety, has already been noticed. There is a large female reproductive gland, situated ventrally.

The movements of this Rotifer were of the briskest order; it never seemed to rest. During fifteen minutes I saw it trying with cilia and trophi to swallow one of its little cousins—*D. taurocephalus*, var. *tenua*. The head of the intended victim was well within its captor's maw, but there it stayed, and *semiaperta* at last gave it up, sailing away for fresh fields, and leaving *taurocephalus* (*tenua*) in quite a disabled condition. This is the only case of cannibalism I noticed.

Hab. *Spirogyra*, in the small pool, and I think also in another, half a mile away over a hill.

Genus **Postclausa**, nov. gen.

Generic characteristics: Body greatly compressed. One cervical eye. Head and foot very flexible, and protrusible. Lorica open in front, but completely closed behind and below, with the exception of a small orifice for the foot. No spines, but knobs in ornamentation. Trophi virgate, but very slender.

XI. *Postclausa minuta*, sp. nov. Plate X., figs. xi., xi.*a*.

Specific characters: Minute; long and low in general shape. There are four ornamental knobs on the lorica—two at the orifice for the head and two at that for the foot. Dorsal cleft very narrow and deep. Eye and brain conjoined in the cervical region.

The smallest Rotifer I have seen, being considerably less than *Diaschiza taurocephalus*. No colour, except that due to food and to the small red eye. The general shape of the Rotifer is that of a very fat sausage, about twice as long as thick, rounded at both ends, and quite wanting in angles. The body proper comprises almost the whole of this outline, since the foot is small and pendent. It projects not from the

posterior of the body, but from its ventral side, about two-thirds of the way back. There is a special little knob-guarded aperture from which it protrudes, and through which it is often wholly retracted. It consists of only one joint, protruding only a short distance beyond the knobs spoken of above, and ending in two toes a little longer than the foot itself. The head is small, and not well defined from the rest of the body. It is rounded off in front, and is, like the foot, entirely retractile within the lorica. Cilia fringe all its anterior face; they are of medium size and rather slow motion. The lorica is, of course, peculiar. Instead of spines it goes in for knobs. Two blunt ones project above and below the head, and two more smaller and better-defined ones project in front of and behind the aperture for the foot. The anterior edge is well defined, and the whole of the rest of the body is encased in this hyaline shell, except for the small ventral foot-hole. The lorica seems fairly dense, especially behind, where it completely closes in the posterior of the animal. The dorsal cleft is very distinct when carefully looked for; it is exceptionally deep, narrow, and well defined. The mastax is of the forcipate type common to the Salpinidæans and Notommatadæans. It is, however, very small and slender, and so rather difficult to draw. The pincer-like portions of the rami are very long, and protrude in front of the rest of the mastax. The alimentary canal is of large proportions, and passes along the dorsal part of the body, then round the posterior part, and for a short distance along the ventral side, till it reaches the posterior junction of the foot and body. It was filled with rounded yellowish masses of food-matter, and was considerably distended. The brain is of fair size, and is situated near the dorsal surface, about one-third of the way back from the head. Its anterior veneer is coloured with a red pigment answering to the eye, which, as far as position goes, bears the same relation to the brain as the peel of half an orange bears to the orange. I saw nothing of the other internal organs.

Movement, fairly brisk, though not so brisk as to make the drawing difficult. Like other compressed Rotifers, it swims on its side almost exclusively while under the cover-glass, though I suppose there is little doubt that it swims upright when in its natural conditions. The head and foot are retracted as wholes with fair frequency.

Hab. The pool.

Rather rare.

XII. *Postclausa circularis*, sp. nov. Plate X., figs. xii., xii.*a*.

Specific characters: Body greatly flattened from side to side. Outline of body from the side almost circular. Lorica not very firm; front edge imperceptibly dwindling away. Only

one instead of four knobs, and that one posterior to the orifice for the foot. Stomach enormous.

Colour: Although almost colourless in itself, this Rotifer is a very striking object on the stage, owing to the great mass of dark-brown and dark-yellow food-matter it contains. There is a rather small red eye cervically, and in some specimens large pink-tinted eggs. In general shape this Rotifer is almost round—indeed, its dorsal and posterior edges form a segment of a perfect circle, and when the head and foot are retracted the circle is almost complete. It is, however, evidently much compressed, so that its roundness is that of a plate, not of a ball, for no specimen that I observed ever moved off its side. The foot is pendent from a small orifice in the lorica, about a quarter of the way in front of the posterior end of the ventral side. It is rather long, being able with its toes to touch the corona; but its chief characteristics are its worm-like flexibility and its hyaline transparency. It is nearly always protruded in a forward direction. The head is not marked off distinctly from the rest of the body except by its protrusion beyond the general outline of the rough circle, and by the line where its invagination ends. It is not covered by the lorica; it is very flexible, and is almost constantly changing shape. It has three indistinct lobes, or more probably a raised central portion. It is in the slight depression at the junction of this central portion with the general surface of the head that invagination commences. The head is not retracted as a whole, but the extremity is pulled in first, just as the tentacle of a snail is, and the anterior part of the head can be seen travelling backwards into the centre of the body, just as the eye of a snail can be seen travelling down its tentacle. The ciliary wreath is restricted in area, covering only the raised central part of the corona, and having a circle of longer cilia in the above-mentioned depression, at which the invagination of the head commences. The lorica is not as much developed as that of *P. minuta*. In no part has it the appearance of such solidity, and in front, instead of having a well-defined edge with two ornamental knobs, it merely dwindles away, gradually merging into the unchitinized covering of the head. One of the knobs, too—that guarding the orifice of the foot—is missing, so that on the whole this may be taken as a less specialised lorica than that of its generic companion. I observed no dorsal cleft in the lorica, so that I have missed the family characteristic; but *P. minuta* is so distinctly a Salpinidæan, and this is so distinctly a close ally of *minuta*, that I have no hesitation in calling this too a Salpinidæan. The mouth is situated at the ventral point of the circular depression. The gullet is very small yet distinct, and leads back to the small, simple, and very slender mastax. After the mastax

comes a perfectly enormous stomach, filling up nearly all the great circular body. It is filled with a great quantity of food-matter rolled up in little balls (fig. xii.*a.*), and varying in colour from dark-brown to dark-yellow. The specimen figured bears three eggs, but, in the other I saw, the whole body-space was filled with food. The intestine rather indistinctly leads round from the posterior part of the body to the ventral side, and so to the junction of the foot and the body. The musculature is faint, but some distinct strands may be seen in the flexible foot. No glands of any kind were observed. The only sense-organ is the eye. It is placed cervically, near the dorsal part of the body, and is wedge- or pyramid-shaped, with the apex pointing downward. It is of the usual red colour. No brain could be observed. In one specimen three large pink-tinted eggs, already segmented, were situated over the orifice of the foot.

The two specimens that I found were both very sluggish; I rather fancy one died while I was observing it, while the other never moved out of its place; so that of the movements of this Salpinidæan I can say almost nothing. It extended and retracted its head and foot with great frequency, and sometimes waved its cilia vigorously, sometimes held them still, but that is all I can say.

Both specimens occurred on the same slide, and were secured from the small pool.

Family Coluridæ.

Genus **Colurus,** Ehrenberg.

Generic characteristics: Body subglobose, more or less compressed. Lorica of two lateral plates, open in front, united on the back, gaping behind and (in general) wholly so up the belly. Frontal hood in form of a hook, not retractile. Foot permanently extruded, of distinct joints, terminated by two furcate toes.

XIII. *Colurus gracilis,* sp. nov. Plate XI., figs. xiii., xiii.*a.*, xiii.*b.*

Specific characters: Lorica in dorsal aspect most gracefully oval. A very slight anterior and posterior dorsal fissure. Ventrally the two lorical plates approach each other in the middle of the ventral line, and then sweep away from each other both posteriorly and anteriorly in an easy graceful curve. Oval in lateral aspect. Foot of three joints, half as long as body, pendent from a point a quarter of the way from posterior body. No eyes.

Absolutely no colour. As this, with the other *Coluridæ*, is compressed, it usually swims on its side, and then presents an oval outline, the greatest breadth of the oval being just

behind the middle. Seen from above the shape is that of a narrow and long, but perfectly true, ovoid, tapering behind but broader in front. The foot consists of three telescopic joints; the last of these has a slightly expanded distal extremity, to which the two small triangular toes are attached. The two toes are usually held close to each other. The length of the foot is such that when flexed its toes reach the base of the head. It is pendent from the body about three-quarters or five-sixths of the way back in the body. The head is of fair size, and is very freely movable on the rest of the body, but is usually retracted. It has a chitinous hood, narrow and hook-shaped. Its anterior edge appears not as a segment of a sphere, but somewhat indented in front, as in *C. bicuspidatus*. The outline of the front of the head is irregular, there being a kind of bay taken out of it above. The ciliated area is small, and confined to the lower half of the front of the head. The lorica is completely closed above, but has a very small median posterior and anterior slit. It is quite open below. The two valves approach each other in the middle of the ventral line, and then sweep away in both directions, but more rapidly anteriorly than posteriorly. There is some slight appearance of longitudinal ridging of the lorica. The mastax is small, of the malleate type, and situated about the junction of the head and body. The alimentary canal passes along the dorsal central region of the body to the origin of the foot. No brain or eye was visible. Two small bright spots, referred to by Ehrenberg as inexplicable, and by Gosse as vesicles of air or oil, lie one on each side of the centre of the middle line, near the dorsal side. Under these lie the large paired reproductive organs.

The movements are active but steady. The frontal hook moves slightly, and as the point of vision is altered its anterior edge appears either straight, curved convexly, or indented in the middle, this last probably being the true shape. There are fairly long periods of foot-anchored rest.

Hab. In the small pool.

Rare.

Genus **Metopidia**, Ehrenberg.

Generic characteristics: Lorica usually depressed, entire, with an opening at each end for the emission of the head and foot. Frontal hood in form of a hook. Foot permanently extruded, of distinct joints, terminated by two furcate toes.

XIV. *Metopidia acuminata*, Ehrenberg. Plate XI., fig. xiv.

Specific characters: Lorica ovate, ending behind in an acute point, occipitally deeply notched between projecting spines, the edges very thin.

To avoid making too many species I have put this under the same name as the Rotifer already described by Ehrenberg. One of the chief differences between this New Zealand variety and that of England is its much greater size, being probably twice the size of the already described *acuminata*. The other varietal differences noted are—(1) My variety has no dorsal cephalic lorical cleft; and (2) the trophi here are well forward in the head, and not back in the neck. Sinking these three differences, the two agree perfectly. Colour, absolutely none. It is greatly depressed, and of a graceful outline. Rather narrowed in front, it swells out till it reaches its greatest breadth half-way back. Then, narrowing rather rapidly, it ends in the sharp median spine of the lorica. The foot is rather short, and composed of three telescopic joints, and ends in two small narrow toes. It trails behind the body when the animal is in motion. The head protrudes, extending forward the regular shape of the body. The cilia fringe the anterior border of the head, and are rather small and numerous. The lorica partakes of the graceful shape of the body. There are two blunt lateral spines in front, and the sharp median one behind. It is, of course, arched dorsally; flat and incomplete behind ventrally. An arched retractile chitinous plate covers the head. The mouth is on the centre of the anterior ventral edge of the head. The trophi, which are situated well forward in the head, and are of rather small size, belong to the malleate type. The muscles working the trophi are strong, especially the band joining the opposite manubria. The lateral muscles of the foot are strongly developed. There is no brain nor sense-organ of any kind, as far as I could see. A small bright spot occurs on the left edge, near the dorsal side, and about one-third the way back from the head; this is probably one of the "oil globules" found in *Colurus*.

The movements of this Rotifer are rather peculiar. It floats slowly forward to a piece of Alga, then flecks its foot sharply sideways, and so springs backwards. Its foot slowly swings back to its first position, while the Rotifer is again progressing by means of its cilia. It always swims on its ventral surface, owing to its depressed shape. I saw only two specimens of this species, close together on the same slide. They came from the same prolific pool.

XV. *Metopidia solidus*, Gosse. Plate XI., figs. xv., xv.*a.*, xv.*b.*, xv.*c.*, xv.*d.*

Specific characters: Lorica nearly circular, depressed. Ventral plate commensurate with the dorsal, but more deeply excavate in the posterior notch. The dorsal plate has a submarginal line of corrugation.

Colour: A pair of cephalic small red eyes. This is, of course, a species greatly depressed—very greatly depressed. The body, viewed from the dorsal side, is almost circular, the head and foot protruding and breaking the outline. The foot has three distinct telescopic joints, ending in two slender toes of medium length. The head is of a regular rounded shape, with two lateral projections, in which the eyes are lodged. The cilia are arranged round the front of the head, are mostly small, but there is a little clump of larger ones in the centre. The lorica partakes of the almost globular shape of the body; it embraces the sides of the head with two rather sharp lateral spines, then swells out and sweeps round as if its posterior end were to be a segment of a circle, but a narrow and rather deep bay just over the foot prevents this, and forms two obtuse points at its starting-place. The corresponding bay on the ventral side is of the same width, but is much deeper, to allow the foot to hang down. The difference in the depth of the two indentations is much greater in my specimens than in those drawn by Gosse. The lower valve of the lorica—if I may say "valve"—is flat, but the dorsal one is arched, most sharply in the middle, and flattened out at the edges. Close to the edge and all round are marks like those of the milling of a coin. This feature suggested the name to Gosse, who first described the species; but I found it an exceedingly variable characteristic, sometimes quite undiscernible. There is an arched retractile chitinous plate covering the head. The mastax is situated just within the anterior edge of the lorica, is of the malleate type, with three or four teeth in the uncus. The alimentary canal holds a winding course down the middle of the body, and enters the cloaca just at the base of the foot. The foot-muscles are feebly developed, as the foot is neither waved about, retracted as a whole, nor joint by joint. A brain of fair size is situated above the anterior part of the mastax. Two small red eyes are situated in protruding lobes on sides of the head. The reproductive organs are of great size, they and large eggs filling up all the body-space not occupied by the alimentary organs.

The movements of this Rotifer are steady and deliberate.

Hab. The alga-covered pool.

Var. *latusinus*. Fig. xv.*d*.

In this variety the anterior and especially the posterior emarginations are very broad, and the ventral one is hardly greater than the dorsal. The points made by the bays in the lorica are not obtuse, but sharp and gracefully bent upwards and outwards.

Family ANURÆADÆ.

Genus **Notholca**, Gosse.

Generic characteristics: Lorica ovate, truncate, and six-spined in front, sometimes produced behind, of two spoon-like plates united laterally; no hind spines. Dorsal surface marked longitudinally with alternate ridges and furrows; expelled egg not usually carried. Lacustrine and marine.

XVI. *Notholca regularis*,* sp. nov. Plate XI., figs. xvi., xvi.*a*.

Specific characters: Body oval in outline, with a slight contraction in the middle. The six spines on the occipital edge are nearly all exactly the same size. Ventral plate slightly shorter than the dorsal one. An open cleft between the two posteriorly, but they are commensurate occipitally and laterally. Semi-marine.

Colour: There is a round red eye of medium size, and a very large russet salmon-coloured egg of more than half the bulk of the whole body. The body is depressed, and looked at from above has the appearance of a tolerably regular oval, slightly broader behind. There is no foot. The head is not sharply marked off from the body, but is seen to have a definite size by its retractability. It continues forwards the regular shape of the body. The ciliary wreath is single, and fringes the corona, on which there are also three prominent setigerous prominences. The centre of these is the narrowest, and slightly the longest. The lorica is entire, depressed, flat below, arched dorsally. The upper and lower valves are not exactly applied posteriorly, but leave an open cleft. Its anterior margin is ornamented with six sharp and graceful spines; four of these spines are dorsal and two lateral. The median cleft between the two inner spines is the deepest. The whole lorica is of hyaline transparency. The mouth is terminal and central. The mastax is of the malleate type, situated at about the junction of the head and body. The alimentary canal passes round to the left side of the body, then bends centralwards again, and ends in the posteriorly terminal cloaca. No especial muscles were noticed, except some ceaselessly active ones in the walls of the rectum, which is always undergoing opening and closing movements like those of a heart. The rectum is attached by muscular bands to the lorica. The only sense-organ is the round eye set in about the centre of the head. No definite parts of the excretory system were noticed, except the contractile vesicle in

* Evidently closely akin to *N. jugosa* (Gosse, Jour. Roy. Mic. Soc., 1887, p. 1), but differing somewhat in general shape, ciliated prominences, position of eye, and absence of furrows.

connection with the rectum, in which the pumping movements are so clearly seen. There was one very large coloured egg, situated definitely to the right and rather to the posterior of the body.

The movements of this Rotifer were always brisk. The whirlpool made by its cilia was noticeably large, strong, and far-reaching. The head was retracted completely, though only occasionally, and then the anterior spines of the lorica were seen to perfection.

I found also another Brachionidæan of very much smaller size, but rather similar appearance. It had no egg. I did not get a complete drawing or description of it, and so have just mentioned it.

Both these Brachionidæans came from a ditch which was in communication with the tidal Akatore Creek. The water was sufficiently saline to taste so, and for the salt to crystallize on the slide.

REFERENCES TO FORMER DESCRIPTIONS OF SPECIES.

I. *Rotifer macrurus*, Ehrenberg, Die Infus., p. 490; Pritchard, "Infusoria," p. 704; Gosse, "Rotifera," p. 107, vol. i.

X. *Diaschiza semiaperta*, Gosse, "Rotifera," p. 80, vol. ii.

XIV. *Metopidia acuminata*, Ehrenberg, Die Infus., p. 477; Gosse, "Rotifera," p. 107, vol. ii.

XV. *Metopidia solidus*, Gosse, "Rotifera," p. 106, vol. ii.

EXPLANATION OF PLATES VIII.–XI.

PLATE VIII.

Fig. i. *Rotifer macrurus*, in act of feeding.
Fig. i.*a*. " side view, in act of creeping.
Fig. ii. *Callidina quadridens*.
Fig. ii.*a*. " the trophi.
Fig. iii. *Hydatina monops*.
Fig. vi. *Mastigocerca flectocaudatus*.

PLATE IX.

Fig. iv. *Notommata pentophthalma*.
Fig. v. *Planoventer varicolor*, side view.
Fig. v.*a*. " dorsal view.
Fig. v.*b*. " the trophi.
Fig. vii. *Mastigocerca rectocaudatus*, dorsal view.
Fig. vii.*a*. " side view.
Fig. viii. *Dinocharis inornata*.

PLATE X.

Fig. ix. *Diaschiza taurocephalus*.
Fig. ix.*a*. " the eye, from above.
Fig. ix.*b*. " the trophi.
Fig. ix.*c*. " var. *tenua*.
Fig. ix.*d*. " trophi of *tenua*.

PLATE X.—*continued.*

Fig. x. *Diaschiza semiaperta.*
Fig. x.*a.* " the trophi.
Fig. xi. *Postclausa minuta.*
Fig. xi.*a.* " the trophi.
Fig. xii. *Postclausa circularis.*
Fig. xii.*a.* " portion of the food-mass in the stomach (enlarged).

PLATE XI.

Fig. xiii. *Colurus gracilis.*
Fig. xiii.*a.* " dorsal view.
Fig. xiii.*b.* " ventral view of lorica.
Fig. xiv. *Metopidia acuminata.*
Fig. xv. *Metopidia solidus.*
Fig. xv.*a.* " side view.
Fig. xv.*b.* " view of ventral half of lorica.
Fig. xv.*c.* " the trophi.
Fig. xv.*d.* " lorica of var. *latusinus.*
Fig. xvi. *Notholca regularis.*
Fig. xvi.*a.* " side view of posterior part of lorica.

ART. XV.—*A List of Marine Shells found at Whangarei Heads.*

By CHARLES COOPER.

[*Read before the Auckland Institute, 10th October, 1898.*]

THE district of Whangarei Heads is on the east coast of Auckland Province, and about seventy miles north of Auckland. For the purposes of this paper the northern boundary of the district is a line from Marsden Point to the Kauri Mountain, and includes the entrance to Whangarei Harbour, the coast-line to Bream Head, and from thence to the Kauri Mountain. The country is mainly composed of volcanic breccia, with dykes of diorite with some slate. There is a good variety in the shore; mudflats, sandy beaches, and heavy boulders make it a favourable place for marine life. Inside the Heads the water is more or less smooth, while outside the beach is exposed to the full force of the waves of the open ocean.

The shells have been collected at various times by shore-hunting and dredging by myself and friends, and I have to thank Mr. H. Suter for his assistance in naming some of them.

Fam. LEPIDOPLEURIDÆ.

Lepidopleurus inquinatus, *Reeve.*

Fam. ISCHNOCHITONIDÆ.

Ischnochiton longicymba, *Q. and G.*

Fam. MOPALIIDÆ.

Plaxiphora suteri, *Pilsbry.*

Fam. ACANTHOCHITIDÆ.

Acanthochites violaceus, *Q. and G.*
" zelandicus, *Q. and G.*
" porosus, *Burrow.*

Fam. CHITONIDÆ.

Chiton quoyi, *Desh.*
" pellis-serpentis, *Q. and G.*
" canaliculatus, *Q. and G.*
Eudoxochiton huttoni, *Pilsbry.*

Fam. ACMÆIDÆ.

Acmæa lacunosa, *Reeve.*
conoidea, *Q. and G.*
fragilis, *Q. and G.*
rubiginosa, *Hutton.*
flammea, *Hutton.*

Fam. PATELLIDÆ.

Patella strigilis, *H. and J.*
" denticulata, *Martyn.*
" radians, *Gmel.*
" stellifera, *Gmel.*

Fam. HALIOTIDÆ.

Haliotis iris, *Martyn.*
" rugoso-plicata, *Chem.*
" virginea, *Chem.*

Fam. FISSURELLIDÆ.

Emarginula striatula, *Q. and G.*
Subemarginula parmophoidea, *Q. and G.*
Scutus ambiguus. *Chem.*

Fam. TROCHIDÆ.

Trochus tiaratus, *Q. and G.*
" oppressus, *Hutton.*
" viridis, *Gmel.*
Monodonta æthiops, *Gmel.*
" excavata, *Ad. and Angas.*
" lugubris, *Gmel.*
Cantharidus iris, *Gmel.*
" purpuratus, *Mart.*
" pupillus, *Hutt.*
" dilatatus, *Sow.*
" rufozona, *A. Ad.*
Gibbula nitida, *Ad. and Ang.*

Monilea egena, *Gld.*
Calliostoma tigris, *Mart.*
" punctatum, *Mart.*
Ethalia zelandica, *H. and J.*

Fam. Stomatiidæ.

Minos rimata, *Hutt.*

Fam. Turbonidæ.

Turbo smaragdus, *Mart., var.* tricostatus, *Hutt.*
" granosus, *Mart.*
Phasianella huttoni, *Pils.*
Astralium (Cookia) sulcatum, *Mart., var* davisii, *Stowe.*
" (Imperator) heliotropium, *Mart.*

Fam. Neritidæ.

Nerita nigra, *Gray.*

Fam. Littorinidæ.

Littorina mauritiana, *Lam.*
" cincta, *Q. and G.*
Fossarina varia, *Hutton.*

Fam. Rissoiidæ.

Rissoia annulata, *Hutt.*
Rissoina rugulosa, *Hutt.*

Fam. Calyptræidæ.

Crepidula aculeata, *Gmel.*
" monoxyla, *Less.*
" unguiformis, *Lam.*
Calyptra calyptræformis, *Lesson.*
" scutum, *Lesson.*

Fam. Cypræidæ.

Cypræa (Trivia) australis, *Lam.* (a few dead shells).

Fam. Naticidæ.

Natica zealandica, *Q. and G.*

Fam. Lamellariidæ.

Lamellaria ophione, *Gray.*

Fam. Janthinidæ.

Janthina fragilis, *Lam.*
" globosa, *Swainson.*
" exigua, *Lam.*

Fam. Cerithiidæ.

Bittium exile, *Hutt.*
Potamides (Cerithidea) bicarinata, *Gray.*
" " subcarinata, *Sow.*
Cerithiopsis terebelloides, *v. Mart.*
Triforis angasi, *Crosse* (two dead shells only).

Fam. SCALARIIDÆ.

Scalaria jukesiana, *Forbes.*
" zelebori, *Frfld.*

Fam. SOLARIIDÆ.

Solarium (Philippia) luteum, *Lam.*
" modesta, *Phill.* (a few dead shells).

Fam. PYRAMIDELLIDÆ.

Turbonella zealandica, *Hutton.*

Fam. TURRITELLIDÆ.

Turritella rosea, *Q. and G.*
" vittata, *Hutton.*

Fam. TRICHOTROPIDÆ.

Trichotropis inornata, *Hutton.*

Fam. STRUTHIOLARIIDÆ.

Struthiolaria papulosa, *Mart.*
" vermis, *Mart.*

Fam. LOTORIIDÆ.

Lotorium nodiferum, *Lam.*
" olearium, *L.*
" spengleri, *Lam.*
" (Argobuccinum) argus, *Gmel.*
" " leucostomum, *Lam.*

Fam. CASSIDIDÆ.

Semicassis pyrum, *Lam.*
" achatina, *Lam.*

Fam. DOLIIDÆ.

Dolium variegatum, *Lam.*

Fam. FASCIOLARIIDÆ.

Taron dubius, *Hutton.*

Fam. MITRIDÆ.

Turricula rubiginosa, *Hutton.*

Fam. BUCCINIDÆ.

Siphonalia mandarina, *Ducl.*
" dilatata, *Q. and G.*
" nodosa, *Mart.*
Cominella maculata, *Mart.*
" maculosa, *Mart.*
" virgata, *Ad.*
" huttoni, *Kob.*
Pisania lineata, *Mart.*
" vittata, *Q. and G.*
" littorinoides, *Reeve.*
Columbella choava, *Reeve.*

Fam. MURICIDÆ.

Trophon stangeri, *Gray*.
" duodecimus, *Gray*.
" plebeius, *Hutton*.
Purpura succincta, *Mart*.
" striata, *Mart*.
" scobina, *Q. and G*.
" (Lepsia) haustrum, *Mart*.

Fam. VOLUTIDÆ.

Scaphella pacifica, *Lam*.

Fam. OLIVIDÆ.

Ancilla australis, *Sow*.

Fam. MARGINELLIDÆ.

Marginella muscaria, *Lam*.
" (Volvaria) mustelina, *Angas*.

Fam. PLEUROTOMATIDÆ.

Surcula traillí, *Hutton*.

Fam. TEREBRIDÆ.

Terebra tristis, *Desh*.

Fam. ACTÆONIDÆ.

Actæon albus, *Hutton*.

Fam. SCAPHANDRIDÆ.

Bullinella striata, *Hutton*.

Fam. BULLIDÆ.

Bulla australis, *Gray*.
" quoyi, *Gray*.
Haminea zealandiæ, *Gray*.

Fam. APLUSTRIDÆ.

Aplustrum lineata, *Wood*.

Fam. CAROLINIIDÆ.

Carolina affinis, *d'Orb*.

Fam. PLEUROBRANCHIDÆ.

Pleurobranchus ornatus, *Cheeseman*.

Fam. SIPHONARIIDÆ.

Siphonaria australis, *Q. and G*.
" zealandica, *Q. and G*.
" redimiculum, *Reeve*.
Gardinia nivea, *Hutton*.

Fam. DORIDIDÆ.

Doris rubicunda, *Cheeseman*.
" flabellifera, *Cheeseman*.
Chromodoris aureo-marginata, *Cheeseman*.
" amœna, *Cheeseman*.

Fam. AURICULIDÆ.

Marinula filholi, *Hutton.*

Fam. AMPHIBOLIDÆ.

Amphibola avellana, *Chemn.*

Fam. SOLENOMYIDÆ.

Solenomya parkinsoni, *Smith.*

Fam. ARCIDÆ.

Arca decussata, *Sow.*
Pentunculus laticostatus, *Q. and G.*
" striatularis, *Lam.*

Fam. MYTILIDÆ.

Mytilus latus, *Chemn.*
" edulis, *L.*
" ater, *Frfld.*
Modiola australis, *Gray.*
Lithodomus truncatus, *Gray.*
Crenella impacta, *Herm.*
Modiolaria lanigera, *Dkr.*

Fam. AVICULIDÆ.

Pinna zealandiæ, *Gray.*

Fam. OSTREIDÆ.

Ostrea edulis, *L.*
" glomerata, *Gould.*

Fam. PECTINIDÆ.

Pecten laticostatus, *Gray.*
" zealandicus, *Gray.*
" convexus, *Q. and G.*
Lima angulata, *Sow.*

Fam. CARDITÆ.

Cardita tasmanica, *Tenison-Woods.*
Venericardia compressa, *Reeve.*

Fam. LUCINIDÆ.

Lucina dentata, *Wood.*

Fam. EURYCINIDÆ.

Kellya citriana, *Hutton.*

Fam. TELLINIDÆ.

Tellina disculus, *Desh.*

Fam. MACTRIDÆ.

Mactra discors, *Gray.*
" æquilatera, *Desh.*

Fam. Mesodesmatidæ.

Mesodesma novæ-zealandiæ, *Chemn.*
" spissa, *Reeve.*

Fam. Veneridæ.

Dosinia australis, *Gray.*
" subrosea, *Gray.*
Venus crebra, *Hutton.*
" stutchburyi, *Gray.*
" costata, *Q. and G.*
" mesodesma, *Q. and G.*
Tapes intermedia, *Q. and G.*
Petricola reflexa, *Gray.*
" elegans, *Desh.*
" siliqua, *Desh.*

Fam. Psammobiidæ.

Psammobia stangeri, *Gray.*
" lineolata, *Gray.*

Fam. Myidæ.

Corbula zealandica, *Q. and G.*

Fam. Glycymeridæ.

Glycymeris zealandica, *Q. and G.*

Fam. Saxicavidæ.

Saxicava arctica, *Sow.*

Fam. Teredinidæ.

Teredo antarctica, *Hutton.*

Fam. Pandoridæ.

Myadora striata, *Q. and G.*

Fam. Spirulidæ.

Spirula peronii, *Lam.*

Fam. Octopodidæ.

Octopus, *sp.*

Fam. Argonautidæ.

Argonauta tuberculata, *Shaw.*

Art. XVI.—*Birds of the Bay of Islands.*

By A. T. Pycroft.

[*Read before the Auckland Institute, 10th October, 1898.*]

The Bay of Islands district, although the cradle of settlement in New Zealand, has not made much progress. This is owing to the broken nature of the country and the poor quality of the land; but these drawbacks have been the means of preserving many of the birds. If the land were good the bush—which is now slowly disappearing before axe and fire—would long ago have been a thing of the past, and some of the birds which are plentiful would be very rare, if not extinct. Old settlers tell me that the bell-bird, North Island robin, saddle-back, and yellow-head were plentiful in the early days of the settlement. They have now totally disappeared, not only here but throughout the North. I have collected during the last three years nearly all of the forty-five species mentioned below.

1. **Glaucopis wilsoni.** (Blue-wattled Crow.)

Rare. I have spent many days searching for this bird, and, although I have skinned several which were obtained for me at Okaihau and Puhipuhi, I have seen none alive.

2. **Myiomoira toitoi.** (North Island Tomtit.)

Rare. Once during a trip to Puhipuhi I shot two. The old natives, to whom I showed the bird on my return, recognised it, but the young natives said it was a "pakeha tuauru."

3. **Gerygone flaviventris.** (Grey Warbler.)

Very plentiful.

4. **Sphenœacus punctatus.** (Fern-bird.)

Common. I have spent many days collecting this bird, which is common in most of the swamps, and when the swamp is not too wet the bird can easily be run down by two or three, but often, when hard pressed, it leaves the swamp and takes to the tall fern and tea-tree; then the task is almost hopeless. After several days' search in a swamp two miles from Opua I obtained its nest and two eggs.

5. **Anthus novæ-zealandiæ.** (New Zealand Pipit.)

Very common. A gentleman at Waitangi possesses the skin of a perfect albino.

6. **Rhipidura flabellifera.** (Pied Fantail.)
Very common.

7. **Zosterops cærulescens.** (Silver-eye.)
Very common.

8. **Prosthemadera novæ-zealandiæ.** (Parson Bird.)
Fairly numerous, but I have sometimes tramped through the bush all day and only seen an occasional one.

9. **Halcyon vagans.** (Kingfisher.)
Very common. I have often seen birds of exceptionally bright plumage, and I have obtained a perfect albino.

10. **Eudynamis taitensis.** (Long-tailed Cuckoo.)
Very rare. I have seen one specimen, and have heard of only two others being obtained in this district.

11. **Chrysococcyx lucidus.** (Shining Cuckoo.)
Very numerous.

12. **Platycercus novæ-zealandiæ.** (Red-fronted Parakeet.)
Rare. This bird is found on the high ranges at the back of Whangaruru and at Puhipuhi.

13. **Nestor meridionalis.** (Kaka.)
Fairly numerous.

14. **Spiloglaux novæ-zealandiæ.** (New Zealand Owl—Morepork.)
Very common.

15. **Circus gouldi.** (Hawk.)
Common.

16. **Carpophaga novæ-zealandiæ.** (Pigeon.)
Fairly numerous, but there is no doubt that in a few years it will be rare in the North, owing to the gradual disappearance of the bush and the bird not being sufficiently protected.

17. **Charadrius obscurus.** (New Zealand Dottrel.)
I have only seen odd birds.

18. **Charadrius bicinctus.** (Banded Dottrel.)
I have only seen odd birds.

19. **Hæmatopus unicolor.** (Black Oyster-catcher.)
I have only seen one.

20. **Limosa novæ-zealandiæ.** (Southern Godwit).
Not common, owing to the absence of feeding-grounds in the harbour.

21. **Larus dominicanus.** (Southern Black-back Gull).

Very common. I have obtained this bird's eggs at Tapeka Point, situated at the entrance to Russell, and also at the Black Rocks, off Moturoa Island. The nest is built of a coarse grass, and is about a foot in diameter, and almost flat and compact.

In November last year several of us went to the Black Rocks, which are composed of basalt, and vary from 40 ft. to 60 ft. in height. Deep water washes the sides facing the ocean, which are perpendicular. The tops are flat, and chasms which are in places not more than 2 ft. wide split up some of the rocks. A heavy swell made the landing difficult, but we were compensated by watching the swell, which was a grand sight, rolling into the chasms and sending the spray many feet above the rocks. The crabs, which were clinging in crevices, scuttled into the seething foam at our approach. We obtained eggs of the black-back gull, mackerel gull, white-fronted tern, blue heron, and the little blue penguin. I enjoyed some of the terns' and mackerel gulls' eggs, which we boiled. One of our party had collected a small bucketful of mixed eggs for pastry. When he reached home the chirping of a chick drew his attention to the eggs, and from a cracked egg of a black-back gull a chick was claiming entrance to the world. The little bird was hatched, safely wrapped up, and placed near the fire. It grew into a fine bird, and always remained about the garden, although its wings were not cut.

22. **Larus scopulinus.** (Mackerel Gull.)

Very common. Breeds on Tapeka Point and the Black Rocks. Its nest is sometimes made of a little grass, but generally the eggs are laid on the bare rock.

23. **Stercorarius crepidatus.** (Richardson's Skua Gull.)

Plentiful from October and November till April. One day I counted as many as six between Opua and Russell. It is interesting to watch the skuas chasing the little terns for their fish. The terns cannot escape their swift assailants, and drop the fish, which the skuas catch as it falls.

24. **Sterna frontalis.** (White-fronted Tern.)

Very common. It breeds on the Black Rocks, and its eggs are laid on the bare rock. I obtained two eggs from a bird nesting on the rocks. One is the usual colour, but the other is a pale-blue. About February and March the young birds leave the rocks in company with the old birds, who feed them for some time afterwards.

25. **Sterna caspia.** (Caspian Tern.)
Very numerous.

26. **Porphyrio melanotus.** (Swamp-hen.)
Common.

27. **Rallus philippensis.** (Banded Rail.)
Common.

28. **Ortygometra tabuensis.** (Swamp-rail.)
Rare. My specimens were taken from a settler's cat.

29. **Ortygometra affinis.** (Marsh-rail.)
Very rare. I have obtained two from Waikare. On dissection the stomach of one contained minute shells.

30. **Ocydromus greyi.** (North Island Woodhen.)
Plentiful, especially in the neighbourhood of Russell.

31. **Ardea sacra.** (Blue Heron.)
Common. I have obtained its eggs at the Black Rocks. The nest is loosely built, and is composed of twigs and rushes placed in some almost inaccessible chasm.

32. **Botaurus pœciloptilus.** (Black-backed Bittern.)
Not very common, owing to the absence of extensive swamps.

33. **Phalacrocorax novæ-hollandiæ.** (Black Shag.)
Common. I have obtained eggs at a shaggery above the Waitangi Falls, where there were three varieties—*P. novæ-hollandiæ*, *P. varius*, and *P. brevirostris*—all nesting in a puriri-tree, which hung over the river.

34. **Phalacrocorax varius.** (Pied Shag.)
Very common. Often on a bright morning I have stood on the side of a cliff and watched this bird fishing in the clear water beneath me. It swims under water with great rapidity, and I have seen it dodging in and out of the seaweed and stones in pursuit of some small fish. The nest is loosely built of twigs, and is generally found on pohutukawa-trees which hang over the water. I have obtained eggs at Cape Brett and in the harbour.

35. **Phalacrocorax brevirostris.** (White-throated Shag.)
Very common. These birds, *P. novæ-hollandiæ*, and *P. varius* have a common shaggery. I have obtained eggs and fully fledged young ones, which are black. An old bird which I shot was white on the breast, with black feathers interspersed, and I have shot others with more or less white on the breast.

36. **Phalacrocorax stictocephalus.** (Little Black Shag.)

Sir Walter Buller has identified and reinstated this bird on the authority of skins sent by me (Trans. N.Z. Inst., vol. xxix). This bird is common in the winter, but is seldom seen in the summer. At the present time—August—they are very numerous, and must consume a great quantity of fish. They seem to have a weakness for the young mullet. I secured eight of these birds at one shot when a flock of about sixty were fishing in front of the Opua Railway-station. I believe they breed inland on the banks of the fresh-water rivers, but I have obtained no eggs.

37. **Dysporus serrator.** (Australian Gannet.)

Very common.

38. **Diomedea exulans.** (Wandering Albatros.)

I have seen this bird several times at the mouth of the bay, and I am told it often enters the little harbour of Whangaruru during the whaling season in search of offal.

39. **Pelecanoides urinatrix.** (Diving Petrel.)

Common.

40. **Ossifraga gigantea.** (Giant Petrel.)

I have a specimen which, with others, followed the s.s. "Rakanoa" up the harbour to Opua, and I have seen them occasionally at the entrance to the bay.

41. **Puffinus griseus.** (Mutton-bird.)

Common. I have obtained its eggs and young from Moturoa Island.

42. **Anas superciliosa.** (Grey Duck.)

Not very common.

43. **Anas chlorotis.** (Brown Duck.)

Common.

44. **Eudyptula undina.** (Little Blue Penguin.)

Common. I have obtained eggs and young ones from breeding-places in the harbour. A pair of these birds nested under an occupied building at Opua.

45. **Apteryx mantelli.** (Kiwi.)

Common in places, especially at Whangae and between Opua and Waimate. It is a frequent occurrence for pig-dogs to secure one and sometimes more kiwis during the day. Unfortunately, birds caught by pig-dogs are generally torn and useless. The country for eight miles behind Opua is very broken and wild, with heavy bush in the gullies, and there

kiwis will be plentiful for some time if not troubled by stoats and weasels. I have a perfect egg, which I felt in a kiwi obtained from a native. Thinking the egg would be broken if laid, I chloroformed the bird and cut the egg out. It is perfect, and I have it yet. I have received eggs from July until February, but the eggs I got in February contained fully developed and feathered chicks.

Art. XVII.—*Notes on the Fourth Skin of* Notornis.

By W. Blaxland Benham, D.Sc. Lond., M.A. Oxon., Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 13th September, 1898.*]

The news that a fourth specimen of *Notornis* had been captured was received with the greatest interest, not merely by naturalists, but by the public generally. The following history of the bird deserves to be recorded, since a statement in a recent text-book on ornithology gives the impression that it is already extinct. Dr. Gadow, in Bronn's "Thierreichs: Aves," says, on page 182 of the systematic part, that the bird "*kürzlich aus-gestorben.*"

I need not here enter into a history of the previous captures; it is fully recorded in Sir Walter Buller's valuable work. Suffice it to recall the fact that the present specimen is the fourth only that has been seen in the flesh during fifty years; or, rather, I should say the capture of which has been recorded by naturalists, because, from various sources, we are led to believe that specimens have been not infrequently killed and eaten by Maoris and by settlers, and parts of the skeletons of several others are known from various parts of the South Island. The present bird was captured on the 7th August, by the dog belonging to Mr. Ross, under the circumstances recorded in the following paragraph which appeared in the *Otago Daily Times*:—

"It appears that on Sunday morning, the 7th August, as the Messrs. Ross lay awake in their bunks, they heard an unusual bird-call in the bush near the edge of the lake, and about 100 yards or so from their camp. In discussing it they came to the conclusion that it was not unlike a certain double call often made by the Californian quail, only more bass—not so sharp and clear as the quail-call. The peculiar call was discussed, but nothing more happened until evening. One of the Messrs. Ross was then taking a walk along the beach just

before darkness set in. When near the spot whence had proceeded the peculiar bird-call in the morning the dog that was with him made a dart into the bush, and shortly after emerged with a bird in its mouth. The bird was not quite dead, and it was at once taken to the camp, where it expired a short time after its capture. Its fortunate captor thought it was a *Notornis*, and it was taken with all speed to the foot of the lake. Involving as it did a twenty-five-mile pull, it was early morning before the foot of the lake was reached; but fortunately there was time to pack the bird securely and despatch it by the mail coach for Lumsden, *en route* to Invercargill."

To this account I will add that the bird was taken to Dr. Young, of Invercargill, who at once communicated with me as to its preservation, and promptly sent the bird to Dunedin, where it arrived on the 11th August. Since that date it has been in the Otago University Museum, and hearty thanks are due to Dr. Young and the Messrs. Ross for allowing it to remain on exhibition here.

An examination of the bird showed it to be a young female, in a thoroughly healthy, clean condition. Owing to the cold weather, it was perfectly fresh on arrival. The dog—evidently a thoroughly trained retriever—had not done any perceptible injury to the skin, but on examining the skeleton it was found that the coracoids had been crushed. The only injury to the feathers was on the neck, round which a string seems to have been tied just behind the head, no doubt for conveyance to Invercargill.

On its arrival I carefully compared this fourth skin with the detailed account given by Buller of the third skin, which is now in the Dresden Museum, and of which the Otago Museum possesses two oil-paintings. I may say that the plate representing *Notornis* in the new edition of "The Birds" is not so accurate a representation of the colouring of the bird as the plate in the old edition, although from a lithographer's point of view the former is a much better picture; the colours, however, are too dull, and there are a few inaccuracies of drawing to which I shall have to direct attention.

The colouration and measurements of the present specimen agree very closely with the account given by Sir Walter Buller, but the bird is rather smaller in all its dimensions; and, as this specimen is a young female, the eggs of which do not exceed $\frac{1}{8}$ in. in diameter, we have every reason to believe that Buller's suggestion that the Dresden specimen was a female is correct. One of the skins in the British Museum is brighter in colouration and larger in size, and he presumes it to be that of the male bird, whilst the second British Museum specimen is also probably a female.

Before proceeding to the description it may be as well to

refer to the name of the bird. The early history of the discovery of the fossil bones in the North Island is well known. To these Owen gave the name *Notornis mantelli*, and this name was also bestowed on the subsequently discovered living specimen in the South Island. But Dr. Mayer, after a careful examination of the skeleton of the Dresden specimen, came to the conclusion that the South Island bird is a different species. He named it *Notornis hochstetteri*.

The examination by the late Professor Parker of the other skeleton in the possession of the Otago Museum, as well as the account given by Mr. A. Hamilton of portions of skeletons in his possession, seem to me to support Mayer's opinion, and for the future the Takahe should be spoken of as a distinct species from the fossil.

	Dunedin Specimen. In.	Dresden Specimen In.
Length from the tip of the beak, along the curvature of the back, to the tip of the tail	23	24½
Length of wing, from the flexure	9	10
Length of largest quill	7	..
Length of tail	4½	4¾
Length of tibiotarsus, measured from the anterior angle of the upper extremity to the articulation of the middle toe	3½	3½
Length of middle toe and claw	3¾	4·1
Length of hind toe and claw	1½	1½
Length of bill, from corner of gape to tip	2$\frac{1}{16}$	2½
Height of bill at the base, across both mandibles, passing through the angle of the gape	2*	..
Total length of head, from tip of beak to back of skull, along the line of the gape	4½	..

*A fraction less.

With regard to the slight difference in colouration between this and the Dresden specimen, I have to make the following remarks. The colour of the beak is not uniform. The base is red, much more scarlet than in the picture either of the first or second edition of Buller. Not only is the soft frontal plate red, but this colour extends along the upper surface of the horny beak itself for a distance of 1½ in.; also, down the sides, in front of the eye, to a distance of ½ in.; and along the lower jaw for nearly the same extent. Thus the whole base is bright-red. This tint then fades into a dull reddish-pink, which extends to the tip; but immediately in front of the red base is a band of much paler pink, imperceptibly deepening in tone towards the tip. In Buller's figure, in the second edition, the beak has an orange tint; and he describes it in his diagnosis as "yellowish." On the perfectly fresh bird, however, it is distinctly pink, but fainter than in the figure of the first edition. The soft frontal plate does not extend so far back as the posterior corner of the eye, as Buller states to be the case (2nd ed., p. 91). On the foot and leg the scales are

reddish-pink—the same colour as the greater part of the beak—without any trace of orange, such as is shown in the figure of the second edition, while the colour is a brighter red than in that of the first edition.

The shape of the bill in the figure of the second edition is entirely wrong so far as the curvature of the lower jaw is concerned. It is represented as being concave downwards, giving a curved sharp point to the beak. On the contrary, the curvature is slightly convex downwards, so that the angle at the tip is greater; and the beak is blunter. The woodcut on page lxxv. is accurate.

The shape of the nostril is variously described. We find this statement on page 91: "Nostrils oval"; and on page lxxv.: "Nostrils round." As these statements occur in the diagnosis of the genus it is important to put on record the real facts. I find the nostril very nearly circular; the longitudinal diameter, however, just exceeds the vertical, the measurements being $\frac{3}{16}$ in. and $\frac{2}{16}$ in. respectively.

With regard to the shape of the tarsi, these are not cylindrical, but laterally compressed. The account of the scales given in the text (2nd ed.) does not agree with the figure. As a fact, the text is correct and the plate wrong. Each of the sides of the tarsus, as well as the front, is clothed with a series of transversely elongated scales, the three series being separated by a series of much smaller and more irregular ones, posteriorly and antero-laterally. I counted fourteen of these scales on the front series.

The number of scales or scutella on the middle toe, including that which ensheaths the base of the claw, is 26 (Buller gives 23); on the inner toe, 18 (instead of 15); on the outer toe, 25 (instead of 21); and on the hinder toe, 7 (instead of 5). No doubt some variation in these numbers is to be expected, but I have thought it worth while to give them for the present bird. As to the shape of the claws, the artist has drawn them too pointed; the tip, like that of the beak, is blunt. Moreover, the hind toe is placed too high up the foot in the figure (2nd ed.)—as a fact, it rises from the same general level as the other three toes, as shown accurately in the figure in the first edition.

The shape of the wing is much less definite and less compact than would appear from the figure. It is, in reality, more rounded posteriorly as it lies against the body. I may mention here that the wing is provided with a spur.

Turning now to the general colouration of the plumage, the following points may be noted. A comparison of the plate in the second edition with the bird itself, freshly killed, and with our oil-paintings, done from the Dresden specimen when it arrived in Dunedin, shows very considerable differences. The

colour in the plate is not that rich indigo-blue characteristic of the bird when seen from in front with the light well on it, but a dull greyish-blue, which does not do justice to the bird's beauty. The wings, again, are not uniformly green, but varied, as is correctly represented in the first edition. The long quills are dark-blue, like the breast, but scarcely so rich in tone; and the major coverts of the primaries are olive-green, or, rather, bronzy-green, like the back. There is a broad band of the same tint across the base of the wing. Each individual quill has the lower part of the vane blue, its upper part brownish, or, in some lights, nearly black. The tail-feathers have not brown shafts, nor are they dark-brown below. I am here only calling attention to defects in the drawing, for nothing can be added to Buller's careful description beyond the expression of opinion that "purplish-blue" does not seem to me quite the right term. I have called it "indigo-blue," as it appears to me that the colour is a pure rich blue.

An interesting fact in regard to the colour of the bird, and one which must be of the greatest value to the bird itself, is immediately noticeable in examining the skin in different lights. The best effect is obtained when the light and the eye are in the same direction and the front of the bird be looked at. But if we now look at the back of the bird—as it would be seen if it were running away from the pursuer—no bright tint is to be seen. The colour is a dull dirty grey, admirably adapted for concealing the bird as it escapes into the bush or amongst any growth higher than itself and capable of casting a shade. The white under-coverts of the tail form, however, a conspicuous mark in the bird, as in so many of its allies, and though more noticeable when seen from the side in contrast with the brighter colours of back and wing, yet, from behind, the white is not so noticeable as might be imagined. It is difficult to say what meaning is to be attributed to this white tail. In many cases, like antelopes, rabbits, &c., it is a "recognition mark," as Wallace has called it, enabling members of the herd to find their fellows at night, or to follow the lead of others in escaping enemies. It usually occurs in animals of gregarious habit, and we should judge therefrom that *Notornis* is gregarious. It is all the more curious, then, that isolated individuals have been caught and nothing seen of their fellows. But from what enemy does *Notornis* flee? What native animal at the present day preys on *Notornis*? Probably none. Then, this "recognition mark" must have come down from a time and a place in which there were enemies. This is a matter which at the present time I will not follow up; but it is evident that it is a matter of some interest and perhaps importance.

Art. XVIII.—*Notes on certain of the Viscera of* Notornis.

By W. Blaxland Benham, D.Sc. Lond., M.A. Oxon.

[*Read before the Otago Institute, 13th September, 1898.*]

Plates XII.–XIII.

On the arrival of the fourth specimen of *Notornis* the viscera were removed by the taxidermist attached to the University Museum (Mr. E. Jennings), and I proceeded to make an examination of such organs as were likely to be of general interest to ornithologists. I regret that I was unable to dissect the bird in a thorough-going and careful manner, but the necessity for preserving the skeleton, and for doing as little injury as possible to it and to the skin, prevented me making as exhaustive a study as I should have wished.

I may mention that this is the first opportunity that has presented itself to any naturalist of examining the internal anatomy of this bird, and I have deemed it of sufficient importance to communicate my observations, accompanied by drawings, to the Zoological Society, in the Proceedings of which they will in due time be published. This will render unnecessary the reproduction of all my drawings in the present communication.

The entire viscera have been carefully preserved in alcohol for future reference or for further study.* An examination of the genital organs revealed the fact that the specimen was a young female; the ovary was small, and none of the eggs exceeded $\frac{1}{8}$ in. in diameter.

I made a special study of the following viscera: (*a*) The alimentary tract; (*b*) the larynx; (*c*) the syrinx.

(*a*.) *The Alimentary Canal.*

The œsophagus and glandular stomach present no features of special interest; but the great size of the gizzard seems noteworthy: it measures $3\frac{1}{4}$ in. by $2\frac{1}{4}$ in., the larger axis, of course, being obliquely transverse. It is of a character usual in graminivorous birds, having very thick muscular walls and

* The contents of the gizzard were submitted to Mr. G. M. Thomson, who kindly volunteered to examine the fragments of "grass" which formed the bulk of its food. Mr. Thomson writes to me as follows: "It is almost certain that the bird has chiefly fed on species of *Carex* and *Uncinia* (cutting-grasses), and what strengthens this view is that these plants are particularly common at the edge of the bush. . . . At the same time, there probably are some pieces of true grass among the *débris*, but I looked at over a score of pieces and they all belonged to the Cyperaceous type."

a thick hard lining within. The latter, as is frequently the case, is continued beyond the thick muscular wall into what appears externally to be the commencement of the intestine.

The intestine measures 48 in. from the pylorus to the point of entrance into the cloaca, from which it had been cut by the taxidermist. The loop of the duodenum measures 5½ in., and has a diameter of ¾ in., the remainder of the gut being slightly narrower. The intestine beyond the duodenal loop is thrown into two large and two smaller U-shaped coils, as in the *Rallidæ* generally. Unfortunately, I was unable to map these out with absolute accuracy in the manner in which Mr. Chalmers Mitchall has done for a series of birds,* as the mesentery had been injured before I examined the viscera, but I have represented them in what appears to be their natural position; but it is needless to describe their arrangement in the present paper. I would refer those interested in the matter to my forthcoming paper in the "Proceedings of the Zoological Society."

There is a vestige of the vitelline duct, about ½ in. in length, at a distance of 24 in. from the gizzard—in other words, at a point half-way along the intestine, at the apex of the second post-duodenal loop. The paired cæca are of considerable length, measuring 9 in. They arise at a point 6 in. from the hinder end of the gut. Each cæcum has the normal shape and arrangement, commencing as a narrow tube and dilating gradually to form a thin-walled terminal sac.

The liver has, as usual, its right lobe larger than the left. The gall-bladder is entirely free from the liver.

There are two bile-ducts, as is generally the case in birds. One of these, since it arises directly from the left lobe of the liver, is known as the "ductus hepato-entericus," or "hepatic duct," to distinguish it from the "cystic duct," or "ductus cystico-entericus," which is connected with the gall-bladder. This latter duct (Pl. XIII. fig. *c.d.*) runs down the mesentery alongside the distal limb of the duodenum, into which it opens on its dorsal surface close to the apex of the loop. The other, or direct hepatic duct, passes along the middle of the mesentery, to open ventrally into the gut close to the former.

The pancreas presents three lobes or regions. The basal lobe is brownish in colour and less compact than the other two, which are yellow (Pl. XIII. fig. *p.b.*). It lies adherent to the duodenal mesentery throughout; on its ventral surface it carries the ventral lobe, which extends beyond the basal lobe forwards to form a finger-shaped process projecting freely from the mesentery, and backwards forms a rounded, broader

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* Proc. Zool. Soc., 1896, p. 136.

lobule, overlying the ventral surface of the apex of the duodenal loop. The dorsal lobe of the pancreas (*p.d.*) is connected with the basal lobe at its posterior end, and runs forward on the dorsal face of the mesentery, close to the distal limb of the duodenal loop. It is only about half the length of the ventral lobe, and its posterior end overlaps the intestine, as that does.

There are in *Notornis*, as in some other birds, two pancreatic ducts—one connected with the dorsal lobe and one with the ventral lobe. The ventral pancreatic duct (*p.v.d.*) arises from the posterior rounded flap or lobule of the ventral lobe of the pancreas, runs across the mesentery, passing ventrad to the hepatic duct, and enters the distal limb of the duodenum just beyond it. The dorsal pancreatic duct (*p.d.d.*) springs from the dorsal lobe, and opens into the duodenum close to the cystic duct.

It seemed worth while to examine the *tongue* with some care and detail. as there can be no doubt that this organ in birds is of great interest and importance. I have given a drawing of it in my paper in the "Proceedings of the Zoological Society," and will not describe it here, as a mere account of it would be tedious.

(*b.*) *The Larynx.*

The larynx is imperfectly ossified, and suggests at once the immaturity of the bird. Detailed figures are given in my other paper.

The glottis is provided with a rudimentary epiglottis in the form of a small rounded cartilaginous knob, slightly overhanging its anterior angle.

The thyroid (or, as recent authors term it, the "cricoid"—refusing to acknowledge its homology with the thyroid of mammals) is a nearly flat, but slightly spoon-shaped, bone, about twice as long as broad, feebly convex ventrally, slightly pointed anteriorly, and truncate behind. The posterior half of its lateral margin is slightly upcurved, and forms a ridge, to which is articulated a bone of nearly rectangular outline, but sharply curved inwards dorsally, so that it nearly meets its fellow of the opposite side, from which, however, it is separated by a median hexagonal bone forming the posterior (dorsal) wall of the laryngeal cavity. It is interesting to note that the rectangular-curve bone is independent of the spoon-shaped bone, for, according to Tiedemann, Dumeril, and other authorities, this posterior piece of the thyroid becomes continuous with the main part of that bone in old birds. This fact again points to the immaturity of our specimen of *Notornis*.

The median hexagonal bone is the "cricoid" of older

ornithologists (or "procricoid" of Fürbringer and other recent writers). It is grooved on its dorsal or posterior face, and laterally receives each of the posterior pieces of the thyroid in a rounded notch. On its upper or anterior face it further articulates with the pair of arytenoids.

Each arytenoid is nearly Y-shaped, the stalk of the Y being directed forwards and the fork backwards.* This Y-shaped bone is, however, curved, so that the outer limb is concentric with the margin of the thyroid, and the inner limb (which is incompletely ossified) bounds the glottis. The posterior end of the outer limb is sharply curved inwards to articulate with the cricoid.

I have described the larynx in some detail, as there appears to be no easily available account of this organ in birds.

The *tracheal rings*, which are incompletely ossified, overlap one another alternately right and left. Each ring is narrow in the median, dorsal, and ventral lines, but widens out laterally. Any given ring overlaps its successor on one side—*e.g.*, right—but is overlapped by it on the other side—*e.g.*, the left, or *vice versâ*. I noted a structure that appears to be of some interest in connection with these tracheal rings—namely, that on the dorsal median line a small nodule of cartilage lies above the narrowed part of each ring; or, rather, the nodules alternate with the rings at this point, but lie more superficially.

(*c.*) *The Syrinx.*

The syrinx, or lower larynx, consists of seven closely apposed rings, of which the fourth carries the pessulus, and appears therefore to be the last tracheal ring (according to Gadow, in Bronn's "Thierreichs: Aves"); consequently, the syrinx is composed of four tracheal and three pairs of bronchial rings.

The membrana-tympanica externa is supported by the last syrinx ring and the three next bronchials.

All the syringeal rings are separate, again indicating, presumably, the immature condition of the bird.

The first syringeal ring (*a*) differs but little from the preceding tracheal rings; it is, however, stouter. The next ring (*b*) differs from the preceding ones in being incomplete dorsally, where each end abuts upon a dorsal cartilaginous

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* Whether or not the anterior end articulates with the thyroid I was unable to determine, as I did not wish to injure or displace the structures more than I could help. I have had to content myself with an examination of one side of the structure only, so that if the bird passes into the possession of a competent ornithologist he may be able to look into such details as are of real importance. As I have no special knowledge of bird-anatomy from the point of view of the systematist, I have purposely done as little damage to the structures as possible.

plate, in which ossification is just commencing. The third ring (*c*) is somewhat larger, and its dorsal extremity on either side curves round the bronchus. The fourth ring (*d*) is stouter than the rest; ventrally it presents a rounded knob, which is produced downwards between the two bronchi: thence it is continued dorsally, as the pessulus, in the angle where the trachea divides to form the two bronchi. This ring (*d*) is, like *b*, *c*, incomplete dorsally, the right and left extremities curving round the upper part of each bronchus, to cease at the membrana-tympanica interna.

The pessulus is a straight long rod, continuous at its ventral end with the ventral knob of the ring (*d*), but terminates dorsally against a couple of small ossicles (*r*), which are not connected with any ring, though possibly they do become co-ossified with one in the adult bird.

The remaining rings of the syrinx (*e*, *f*, *g*) call for little remark; they are incomplete internally, and embrace only the outer surface of the bronchus, the inner surface of which is formed by the membrana-tympanica interna. These three bronchial half-rings are closely apposed externally, and the lower margin of *g* is concave backwards. Between it and the next bronchial ring (i), and between (i.) and (ii.) and between (ii.) and (iii.), is stretched a thin membrane, the membrana-tympanica externa. Then follow normal bronchial rings. From the restriction of this membrane to the side of the bronchus this kind of syrinx is termed a "bronchial syrinx."

This apparatus of *Notornis* does not closely agree with any that are figured in Bronn's "Thierreichs" by Gadow, nor with other figures with which I have compared it; hence I have described it in some detail. The syrinx which is least unlike that of *Notornis* is that figured by Beddard for *Ægotheles novæ-hollandiæ*, so far as the arrangement of the membrana-tympanica externa is concerned.

There is one point in which *Notornis* appears to be unique, though I am willing to admit that this may be due merely to my ignorance of avian anatomy. According to Gadow (in Bronn's "Thierreichs") the ring which carries the pessulus is to be regarded as the last tracheal. Now, as I have stated, the ventral end of this bone springs from the fourth ring, which is therefore tracheal; yet the dorsal ends of this same ring undoubtedly belong to the bronchi, round which they curve, for here indeed they are separated from the trachea by the dorsal ends of the third ring. Consequently, a ring is both tracheal and bronchial. This is a matter of interpretation; the facts are certain.

Connected with the larynx various muscles have been described. Of these, one, the bronchio-desmus, is stated to be constant. However, I have failed to recognise it, unless

it be represented by a structure partially membranous partially muscular which passes from the lower region of the membrana-tympanica interna, on each side, to the wall of the œsophagus.

The only other muscle which exists in relation to the syrinx in *Notornis* is the tracheo-bronchialis, which is attached to the side of the ring (*d*).

EXPLANATION OF PLATES XII., XIII.

Plate XII.

General View of the Viscera.

b.w. Body-wall.
c. End of one of the paired intestinal cæca.
d. Portion of duodenum.
G. Gizzard.
g.v. Gastrohepatic vein.
I. Intestine.
L.L. Left lobe of liver.
P. Pancreas.
R.L. Right lobe of liver.
st. Stomach.

Plate XIII.

Fig. 1.—View of the Duodenal Loop, with Liver turned forwards.

c.d. Cystic duct.
G. Gizzard.
G[1]. Short continuation of gizzard.
g.b. Gall-bladder.
h.d. Hepatic duct.
L.L. Left liver lobe.
p.b. Basal portion of pancreas.
p.d. Dorsal lobe of pancreas.
po.v. Portal vein.
p.v. Ventral lobe of pancreas.
p.v[1]. Free projection of same.
p.v.d. Ventral pancreatic duct.
py. Pylorus.
s.l. Suspensory ligament.

Fig. 2.—Posterior Portion of Duodenal Loop, seen from the Dorsal Surface.

c.d. Cystic duct.
p.b. Basal portion of pancreas.
p.d. Dorsal lobe of pancreas.
p.d.d. Dorsal pancreatic duct.

Art. XIX.—*A Re-examination of Hutton's Types of New Zealand Earthworms.*

By W. Blaxland Benham, D.Sc. Lond., M.A. Oxon., Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 18th October, 1898.*]

In the year 1876 Captain Hutton read before the Otago Institute a paper entitled "The New Zealand Earthworms in the Otago Museum," * in which he described six new species of earthworms, four of which he locates in the genus *Lumbricus* and two in that of *Megascolex*. At that time—now more

* Trans. N.Z. Inst., vol. ix., p. 350.

than twenty years ago—very little was known of the internal anatomy of the group, or of the characters which serve to differentiate genera from one another. Indeed, up till 1872 the only extra-European genera that had received distinctive names—which are still retained—were *Pontoscolex* and *Perichæta*, Schmarda (1861). The anatomy of the latter had been studied by Vaillant (1869). Closely similar to it externally, and often confused therewith, is the genus *Megascolex*, described from external features by Templeton in 1844. Several other genera had, however, been named from external characters alone, but most of these are now unrecognisable, and have dropped out of zoological literature.

Now, *Perichæta* and its ally *Megascolex* differ from all other earthworms—with the exception of a genus to be mentioned below, and only defined in 1892—in having very numerous bristles or chætæ, and in having them arranged in a circle round each segment of the body, instead of possessing, as does *Lumbricus*, only eight bristles per segment, and in having these more or less in couples or pairs on the lower surface. Of course, this is only one out of many features, external and internal, in which the two genera differ, and it is mentioned here as being the chief reason which led Hutton to identify the worms as he did.

In 1872 a very important memoir on the exotic earthworms contained in the Paris Museum was published by E. Perrier,* in which he examined his material anatomically, and thereby distinguished among worms with eight chætæ a number of new genera; but it does not appear that Hutton was acquainted with this memoir at the time he wrote his paper in 1876, and hence arose some of the errors in his identification of the worms of the Otago Museum. Later on he became acquainted with the contents of Perrier's memoir, for in the "New Zealand Journal of Science" (vol. i., 1883, p. 586) he suggests, wrongly, that two of his species of *Lumbricus* may belong to Perrier's genus *Digaster*, while Mr. Smith speaks of some of them as *Endrilus*, which is probably a misprint for *Eudrilus*, but neither writer states the grounds for using either of these names.

During the last fifteen years the literature dealing with earthworms has assumed very large proportions, chiefly at the hands of half a dozen zoologists in Europe; and, as the number of species and genera have been increased, and the various continents and islands of the world have contributed their quota of material, thanks to the trouble taken by residents and travellers, we have been able to recognise that, just as certain birds and mammals have their special geo-

* Nouv. Archiv. du Museum d'hist. nat. de Paris, 1872.

graphical limitation, so have earthworms. We know that certain genera have their home in certain definite portions of the land or zoological regions, and that certain species of these genera are peculiar to certain definite areas of each region. Further, we have to recognise that a native fauna of worms may be interfered with by the introduction of foreign worms, in the same way that native birds tend to disappear at the hands of man, or his accompanying animals. From the accumulated knowledge, then, of recent years we know that the worm *Lumbricus* is a characteristic European (and perhaps North American) genus, and that it does not occur in other parts of the world unless carried thither by man. We know this from the fact that no distinct species of *Lumbricus* (and its allied genera, which have recently been separated from it) occur outside Europe and North America; consequently, when Hutton described *Lumbricus*, n. sp., from New Zealand, lumbricologists felt pretty sure that an error had been made, and, moreover, the description, as given by him, served to show that the identification was impossible.*

Just as New Zealand has its special and peculiar birds, so it has peculiar species and genera of earthworms. These genera belong to the family *Acanthodrilidæ*, which differ from *Lumbricus* in every possible way, except that they have generally eight bristles in each segment; and Hutton's diagnoses of his species of *Lumbricus* indicated that they belong to this family.

As to the *Megascolex*, too, this genus, though having a wide distribution, and occurring in Australia, has certainly not been recorded from these Islands; but there is a very deceptive similarity between *Megascolex* (a *Perichæta*) and a genus of the family *Acanthodrilidæ* to which I gave the name *Plagiochæta* some few years ago, and from Hutton's brief account of the *Megascolex*, n. sp., it seemed pretty certain that they belonged to this genus.

As I have for the last thirteen years spent a good deal of my time in the study of worms from all parts of the world, it was natural that I should wish to examine the New Zealand representatives at first hand. Our knowledge at present depends almost entirely on the able researches of my friend Mr. Beddard, who has been able to give a detailed account of the anatomy of our native worms, and to describe a considerable number of species, owing mainly to the kindness of the late Professor Parker and of Mr. W. W. Smith, of Ashburton, both of whom have from time to time sent specimens Home to him. There is, however, still some work to be done, especially in the biology of the group, though we already have some very

* For instance, Beddard, Proc. Zool. Soc., 1885, p. 812.

interesting and valuable contributions to this subject from the hands of Mr. Smith.* I hope to complete and extend the work along both lines of research, especially as Beddard's observations deal with preserved material, and with comparatively small numbers of specimens. I hope to examine large series in a comparative manner, to ascertain how far variation occurs, and especially to add details of colouration and habit to Beddard's accounts of anatomy. One of my first steps in this direction after my arrival at Dunedin was to examine the types of Captain Hutton's species, which I fortunately discovered in the store-room of the Otago University Museum. The following are the names of the types as given by him, with certain remarks upon them:—

1. **Lumbricus uliginosus.**

I was unable to find the type; but it is evident from Hutton's description that the worm belongs to the family *Acanthodrilidæ*, and may possibly be identical with Beddard's *Acanthodrilus novæ-zelandiæ* or *A. rosæ*.

2. **Lumbricus campestris.**

There are three bottles so labelled—(*a*) Collected in "Dunedin"; (*b*) "Water of Leith"; and (*c*) "From Wellington."

(*a*.) The bottle labelled "Dunedin" contained two specimens, mature and well preserved, which were at once recognisable from the forward position of the clitellum as Acanthodrilids. The fact that there is only one pair of papillæ, on the 17th segment carrying the pores of the spermiducal glands, in place of two pairs—on the 17th and 19th—as in the rest of the family, characterizes it as *Neodrilus*,† of which only one species is at present known—viz., *N. monocystis*—with which this specimen closely agrees. Moreover, I have myself collected this species under logs in the neighbourhood.

(*b*.) Contains a single individual, and the posterior end of another. This is also *Neodrilus*.

(*c*.) The bottle from Wellington contains three specimens, of which one is smaller than the others. All agree in external characters, and are nothing else than *Lumbricus rubellus*, Hoffmeister. The prostomium, as in all the species of the genus *Lumbricus*, reaches back to the groove between the 1st and 2nd segments; the clitellum occupies segments 27 to 32, but the 26th shows some glandular modification. The tubercula pubertatis are on segments 28 to 31. The worm is

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* Trans. N.Z. Inst., vols. xix., xxv., and xxvi.

† For description, see Benham, Quart. Journ. Microsc. Sci., xxxiii., 1892, p. 289; and for remarks, see Beddard, "Monograph of the Order *Oligochæta*," p. 535.

smaller than usual, being $1\frac{1}{2}$ in. to 2 in. in length, but agrees throughout with this species.

Now, a reference to Hutton's description shows that he had both *Neodrilus* and *L. rubellus* before him, for he says, "Colour reddish"—as is the case for the latter worm—"or olivaceous-green"—which is the tint of the former. The position of the clitellum is said to be "irregular, commencing in any segment from 10 to 20." This is quite inaccurate for either worm, but points to *Neodrilus.* "The male genital pores"—*i.e.*, the spermathecal pores, as we now know them to be—"are on the 9th segment." This evidently refers to *Neodrilus,* in which worm they are conspicuous between segments 7/8, whereas in *Lumbricus* they are scarcely visible.* The vulvæ—by which term is meant the male pores —are stated to be "on the two last segments of the clitellum," which evidently refers to *Neodrilus.* His description of the prostomium may apply to either worm. The fact that "the olivaceous specimens occur in the bush" is perfectly true, while *L. rubellus* is common in the gardens, &c., in the town.

As Hutton mixed two distinct worms, it is impossible to retain his specific name, so that *L. campestris* must disappear, and *monocystis* will remain as the specific name of *Neodrilus.*

3. **Lumbricus levis.**

There are two bottles so marked: (*a*) "From Hampden"; (*b*) "From Dunedin."

(*a*.) This bottle contains only one worm, collected at Hampden; it measures $1\frac{5}{8}$ in. long. The four chætæ on each side are nearly equidistant, or, if *a* be the ventralmost chæta, the distance a–b = c–d, while the distance b–c is slightly greater; and a–a = d–d = 2 ab—*i.e.*, the distance between the lowermost pair or between the uppermost pair is twice the distance between the individuals of a couple. The clitellum occupies segments 14 to 19. The worm is distinctly an Acanthodrilid, and probably belongs to the genus *Octochætus.* Since the worm is not fully mature, I cannot recognise the details concerning the arrangement of the genital pores; but internally I find the following features: The dorsal vessel is double throughout, commencing at the gizzard, which is in segment 6. There are the usual two pairs of spermathecæ, in the 8th and 9th segments, each with a single diverticulum lying in the same segment as the main sac; but no further characters of a diagnostic character were observable without doing injury to the type.

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* In the method of enumerating the segments we have to subtract *one* for Hutton's numbers, as he appears to have counted the prostomium as the first segment, as was the custom then.

I am unable to identify it with any of Beddard's species of *Octochætus*, though it approaches in size his *Acanthodrilus paludosus*; it must be left as *O. levis*.

(*b*.) The bottle labelled "Dunedin" contains also a single individual, measuring 4 in.; it is *Allolobophora caliginosa*, an imported Lumbricid, and a very common worm in the neighbourhood.

Hutton's statement that the clitellum commences "between the 15th and 25th" segments is evidently due to a confusion of the two distinct worms, which may have agreed in colour. The following sentence likewise shows this: "Male genital openings on the 10th to the 15th segments." In *Allolobophora* the male pore is on the 15th, in Acanthodrilids the spermathecal pore is in the region of the 10th segment. Further, "Vulvæ on the two last segments of the clitellum" may refer either to the spermiducal gland-pores of Acanthodrilid or to the tubercula pubertatis of the Lumbricid.

4. **Lumbricus annulatus.**

One bottle, labelled "Dunedin," contains four individuals, only one of which possesses a clitellum; the three others, though immature and badly preserved, show by their size and by the position of the first dorsal pore that they are the same species as the mature specimen, which is the common British brandling worm, *Allolobophora fœtida*. Hutton himself recognised the resemblances, and considered the possibility of the identity. I must correct his statement that the clitellum is "not tuberculated inferiorly"; the tubercles, indeed, exist on the usual segments—28, 29, 30, and partly 31—but they form a continuous though indistinct ridge. Again, the "male openings"—here he means the male pores, not, as usual, the spermathecæ—are on the 15th segment, not on the "16th."

Now we come to his two species of *Megascolex*:—

5. **Megascolex sylvestris.**

One bottle, from Dunedin, contains two entire individuals and two portions. All are very poorly preserved, but are sufficiently in condition to show that the worm belongs to the genus *Plagiochæta*, Benham,* as Beddard has already surmised.†

At present only one species of *Plagiochæta* is definitely characterized—viz., *P. punctata*, which was collected by Mr. E. Vaughan Jennings at Maungatua, and sent to the British Museum, for the authorities of which I examined and named

* "Notes on Two Acanthodriloid Earthworms from New Zealand," Quart. Journ. Micros. Sci., xxxiii., 1892, p. 289.

† Proc. Zool. Soc., 1892, p. 667.

it. This *M. sylvestris*, of Hutton, agrees very closely with *P. punctata*, but differs from it in the following points: (1.) It is not so depressed, being nearly circular; this may be due to its poor preservation. (2.) The dorsal and ventral gaps in the circle of chætæ are equal, and measure only twice the normal gap, whereas in *P. punctata* the dorsal gap is four times the normal. (3.) The prostomium is not entirely imbedded in the 1st segment; it is possible that my specimens of *P. punctata*, in which the prostomium appears to reach the 2nd segment, had shrunk in preservation, so that the two segments approach and hide the hinder edge of the 1st segment. (4.) There are only three pairs instead of four pairs of sperm-sacs; the first pair is on the septum between 9 and 10, and pushes into both these segments. (5.) The chætæ measure, on an average, 0·19 mm.; the ventralmost couple, in sections, reaching 0·22 mm.; and the smallest are 0·165 mm.

From these facts it is difficult, at present, to determine whether *M. sylvestris* is or is not identical with *P. punctata*, for so long as only one species is known it is impossible to say what are specific characters, and we must wait till further information about the genus is to hand.

6. **Megascolex lineatus.**

This was collected at Queenstown; the single bottle contains one entire individual and three broken specimens. All are so soft that they break on handling. The length of the complete individual is only 1½ in. (Hutton gives 2 in.—perhaps for the living worm). The drawing of the prostomium is wrong in representing it small; it is more like that of the preceding species. The chætæ are not in a continuous circle, but quite evidently in couples, as Hutton figures for *M. sylvestris*; in fact, the worm is an undoubted *Plagiochæta.*

If we may judge from the state of preservation, the present species was more deeply pigmented than *M. sylvestris*, for it is not so absolutely bleached by the spirit as that worm; it is, in fact, a very faint brown. The dorsal gap in the circle of bristles measures three times, and the ventral gap twice, a normal gap between two successive couples.

This worm differs from *P. punctata* in the following characters: (1.) The spermiducal pores are carried by papillæ, and there is no defined ridge surrounding the ventral area on which the pores lie (this may, of course, be due to the preservation of the worm). (2.) The spermathecæ have two peculiar diverticula, instead of a single simple cylindrical diverticulum; of these, one is an oval pouch, the other is a three-lobed pouch with a narrow neck; the two pouches open close together into the duct of the main sac. This is a very definite specific character. (3.) The chætæ measure

0·22 mm., and are stouter and more strongly curved than in the preceding species.

Both these species of Hutton's agree with *P. punctata* in having 13 couples of chætæ on each side of each segment. Each couple is inserted between two bundles of longitudinal muscles, which number therefore 12 on each side, together with a broader dorsal and ventral bundle separating the uppermost and lowermost couples of each side. In the three species—or, perhaps, I ought to say three individual specimens—hitherto examined the chief difference visible in section lies in the width of the median muscle-bundles—*i.e.*, the gap between the right and left couple of chætæ—as well as in the length and proportions of the chætæ. The position of the nephridiopores is identical, being between the 3rd and 4th muscle-bundles, or between the 9th and 10th muscle-bundles counting from below, for the pores alternate in position as in so many of the Acanthodrilids.*

With regard, then, to these two individuals described by Hutton, there is no doubt that *M. lineatus* is distinct from my species, while I am uncertain about *M. sylvestris*, and if further research—upon which I am now engaged—shows that it is identical with *P. punctata*, Hutton's specific name will have to replace that given by me.

For the present we may summarise the types as follows:—

1. (?) **Acanthodrilus uliginosus**, Hutton.
   Syn. *Lumbricus uliginosus*, Hutton.

2. (*a.*) **Neodrilus monocystis**, Beddard.
   Syn. *Lumbricus campestris*, Hutton (in part).

   (*b.*) **Lumbricus rubellus**, Hoffmeister.
   Syn. *L. campestris*, Hutton (in part).

3. (*a.*) **Allolobophora caliginosa**, Savigny.
   Syn. *Lumbricus levis*, Hutton (in part).

   (*b.*) **Octochætus levis**, Hutton.
   Syn. *Lumbricus levis*, Hutton (in part).

4. **Allolobophora fœtida**, Savigny.
   Syn. *Lumbricus annulatus*, Hutton.

5. **Plagiochæta sylvestris**, Hutton.
   Syn. *Megascolex sylvestris*, Hutton.

6. **Plagiochæta lineatus**, Hutton.
   Syn. *Megascolex lineatus*, Hutton.

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* pl. xv., fig. 17, *loc. cit.*

Art. XX.—*On New Zealand* Ephemeridæ: *Two Species.*

By C. O. Lillie, M.A., B.Sc.

[*Read before the Otago Institute, 15th November, 1898.*]

Plates XIV.–XIX.

The *Ephemeridæ* are insects with a long, soft, 10-jointed abdomen, furnished at its hinder end with either two or three many-jointed setaceous or filiform tails (caudal setæ). The body is smooth and glabrous. The head is free, with atrophied mouth-organs and carinated epistoma; short subulate antennæ, composed of 2 or 3 short stout joints, succeeded by a many-jointed setaceous awn, three ocelli, and large oculi (compound eyes). Thorax robust, mesothorax predominant, sternum[1] well developed; fore wings ample, erect or spreading in repose, slightly plaited lengthwise; legs slender, femora strong, the fore coxæ somewhat distant from the others. The abdomen in the male armed with a pair of claspers (forceps) placed ventrally at the extremity of the penultimate segment; the vasa deferentia have each a separate intromittent organ, situated at the ventral joining of the ninth and tenth segments.

Peculiarities in structural detail are often noticeable in both or one of the sexes, and are chiefly presented by the ocelli, wings, legs, and caudal setæ; and in the male by the ocelli and forceps. The ocelli are always much larger in the male than in the female, and are divided into two parts transversely; the upper portion has larger facets than the lower, and is sometimes coloured differently.

The fore wings are usually trilateral, ample and rounded off at the extremities; they are relatively longer in the female. The hind wings in some of the genera are not developed; in others they are very minute; and generally they are not very large. Their usual form is triangular-ovate, or oblong-ovate, with a salient prominence in front, either close to the wing-roots or midway towards the apex, in which case the prominence is sometimes followed by a deep depression. Their neuration is fairly plentiful. The inner margin of the fore wing and the anterior margin of the hind wing hitch together automatically to a larger or smaller extent when the wings are spread open. The wing-membrane is usually glassy or iridescent in the adult. Wing-neuration in the *Ephemeridæ* is less complicated than it appears to be, and when difficulty is experienced in ascertaining the homologies

of the nervures it is likely to be occasioned by the suppression of some of them. Unstable in minutiæ, so closely is the essential plan of neuration adhered to by nearly related may-flies that the general facies of the wing is an important aid to classification. The nervures are numbered in the diagrams as follows: 1, the costa, coincident with the anterior margin of the wing; 2, the subcosta; 3, the radius; 4, the sector; 5, the cubitus; 6, the præbrachial; 7, the pobrachial; 8, the anal; 9^1, 9^2, &c., axillary nervures; 10, the sutural, coincident with the inner margin.

The nervures of the fore wing arrange themselves in three groups. The first—consisting of the costa (1), the subcosta (2), and the radius (3)—communicates directly with the thorax; the second—containing the sector (4), the cubitus (5), the præbrachial (6), and the pobrachial (7)—is either annexed to the first group, or terminates in the wing-membrane adjacent to it, close to the base of the wing; the third group—consisting of the anal (8) and the axillary nervures (9^1, 9^2, &c.)—is associated with the prominent curved or angulated crease in the membrane which forms the boundary of a depression posterior to the great cross-vein and close to the wing-roots. By careful inspection of the third group of nervures, observing especially the disposition of the proximal extremities of the main nervures along the prominent curved fold of the membrane, the form of the area contained by the first axillary nervure and the inner margin of the wing, or of the area enclosed by the first and second axillary nervures, and lastly by the general aspect of the adventitious and other nervures, the approximate affinities of *Ephemeridæ* to one another can be ascertained very easily. Cross-veinlets are generally of small account in classification.

In the nervures of the hind wing the cubitus (6) is transferred from the second group, and is annexed to the radius (3), the sector and other adventitious nervures either remaining apart from both or forming a union with either of them. The anal nervure (8) is transferred to the second group. The axillary nervures forming the third group generally occupy a very limited space.

The legs present great differences, some sexual, some generic. The fore legs are always longer in the male than in the female, and are usually longer than either of the hinder pairs. The fore tarsus is often as long as the tibia; in the male frequently much longer. The number of tarsal joints is 5, or 4. The ungues of the fore tarsus are sometimes alike in size and form; often unlike.

The forceps of the male are 2-, 3-, or 4-jointed, with the basal joint, or the next, longest. In some genera they afford good distinctive characters of species.

Much diversity is exhibited in the number and relative proportions of the caudal setæ.

The term "nymph" is used to denote all the subaqueous stages in the development of the young after hatching. In general form they resemble the adult. The tracheal branchiæ are movable, membranaceous, or filamentose appendages to the integuments, enclosing branching tracheæ. The term "subimago" is used to denote the penultimate stage in the life of such of the *Ephemeridæ* as moult once, after direct respiration through the stigmata has been established, and the wings have become fully expanded. The chief points by which this stage can be distinguished from the adult are—the dulness of the integuments, particularly of the wings; the ciliolate terminal margin of the wings in many genera; the shortness of the fore legs; the greater hairiness and shortness of the caudal setæ; the less protuberant and less highly coloured ocelli; and in the male the marked shortness and stoutness of the limbs of the forceps.

The above account is condensed from Eaton's Monograph.

In the "Revisional Monograph of Recent *Ephemeridæ*, or Mayflies," by the Rev. A. E. Eaton, M.A., published in the "Transactions of the Linnæan Society," London, 1888, the following genera are given as represented in New Zealand :—

Ephemera (1 species).—Undescribed.
Atalophlebia (3 species). — *A. dentata*, *A. nodularis*, *A. scita*.
Coloburus (1 species).—*C. humeralis*.
Siphlurus (1 species).—Doubtful.
Oniscigaster (1 species).—*O. wakefieldi*.
Chirotonetes (?) (1 species).—*C. ornatus*.

Thus it will be seen that six species are described, but of these the nymph stage of only one (*Oniscigaster wakefieldi*) is known.

During the present summer I succeeded in rearing a number of insects of two species of *Atalophlebia* from the nymph stage, and am consequently able to describe all three stages.

Genus Atalophlebia, Etn. (1881).

Adult.—Hind wing in front somewhat arched, the summit of the arch obtusely subangular, situated usually before the middle of the curve; subcosta (2) strongly arched, meeting the margin very obliquely; radius (3) nearly straight, constituting, as it were, the chord of the arch described jointly by the subcosta and the portion of the margin included between its extremity and the radius; hence, while the narrow marginal area is broadest at the base and acuminate at its termination, the submarginal area is broadest either in the

middle or a little way before the middle, and tapers gradually to its oblique apex. Cross-veinlets abundant in the fore wing. At the terminal margin the longitudinal nervures are provided with curved simple branchlets, and there are no isolated veinlets. The two intercalar nervures of the anal-axillar interspace of the fore wing have simple branchlets, and usually the hinder one close to its proximal extremity curves forward to unite with the other, which similarly curves forward to unite with the anal nervure. Guard at the orifice of the mesothoracic spiracle small and triangular. Forceps limb of male 3-jointed, the proximal joint much longer than the remainder, somewhat compressed, and in its basal half broadly dilated beneath; the deflexible basis, usually prominent in the middle of the distal border, is otherwise merely emarginate; the corresponding lobe in the female, usually bifid and sharply excised with acute triangular points, is seldom emarginate only. Segments 6–10 constitute about half of the abdomen; segment 8 (the longest) is nearly equalled by segment 7; the others are successively shorter. Median caudal seta about as long as the others, seldom thrown off by specimens; outer setæ, in both sexes, usually double the length of the body. Tarsal ungues all nearly alike, small, narrow, and hooked at the tip. In normal species the male fore tarsus is nearly as long as the tibia, or a little longer than it, and the latter is about one and a half times as long as the femur; the female fore tarsus is nearly half the length of the tibia, which is about one and one-third times as long as the femur.

Nymph. Hitherto unknown. Considering the marked differences in the two nymphs here described, it is hard to say what the generic characters might be.

Atalophlebia scita, Walker.

Nymph ♀ (living). Plate XIV., figs. 1*a–p*.

General colour brownish-black or greyish-black; eyes black; wing-covers black or lighter grey; double median line along dorsal surface of the abdomen; terminal segment yellow; tracheal branchiæ yellowish-grey, veins pitch-black; legs dusky grey, a yellow spot at the proximal and distal ends of the femora; setæ dull grey, becoming lighter towards the extremities; middle seta slightly longer; angle between the setæ about 50°. Length of body, 9 mm.; length of setæ, 12 mm.

The colour differs according to the interval from moulting. Young nymphs and individuals just moulted are greenish-grey. The moults are many. The males in the later stages are distinguished by their bi-lobed eyes, the upper lobes being red.

Hab. Streams about Dunedin, &c.; on stones. Extremely common. The eggs found in jelly-like patches on stones in the streams are probably those of this insect.

Subimago ♀ (in alcohol). Plate XV., figs. 2*a–d*.

Wings dark sepia-grey; posterior margins ciliolate; neuration black; broad yellow median band on thorax, widening into an oblong patch posteriorly; setæ warm sepia-grey, with dark joinings. The subimago stands on all three pairs of legs, with wings erect. The moult into the imago stage takes place twenty-four hours or more after emergence from the nymph.

Imago ♂ (in alcohol). Plate XVI., figs. 3*a–m*.

Thorax piceous; eyes bi-lobed, upper lobes light-red; abdomen dusky brown edged with black, lighter median line, and pairs of yellowish spots on segments 3–6; forceps luteous; setæ warm grey, joinings black; fore femur reddish-brown; hinder legs fulvous; tarsi greyish. Wings vitreous, neuration pitch-black. In the fore wing a yellow spot at the base of the costa; subcosta and radius luteous. Marginal and submarginal areas slight luteous tinge. In the marginal area seven cross-veinlets before the bulla and fifteen after it. The insect stands on its two hinder pairs of legs.

Imago ♀ (in alcohol).

Similar. About seven cross-veinlets before the bulla in the marginal area of the fore wing, and about sixteen behind it. Length of body, ♂ 10 mm., ♀ 9 mm.; length of wing, ♂ 11 mm., ♀ 10 mm.; length of setæ, ♂ 16 mm., ♀ 13 mm.

Atalophlebia nodularis, Etn. Plate XVII., figs. 4*a–l*.

Nymph ♂ (living).

Dull brown, with legs and edges of abdominal segments luteous; dark-brown spots at the extremities and middle of the femora; wing-covers piceous. The abdominal segments have distinct lateral flanges, the posterior angles of which are, in segments 6, 7, and 8, produced into teeth; the fifth segment is the widest. Length of body, 10 mm.; length of setæ, 4 mm.

Hab. Streams near Dunedin, &c.; generally found on soft mud at the bottom.

Not nearly so common as the last species.

Subimago ♀ (in alcohol).

Wings sepia-grey; nervures pitch-black, the colour diffused round the cross-veinlets. The bulla surrounded by a dark spot, and another midway towards the tip. The subimago stands on all its legs. The moult to the imago takes place twenty-four hours or more after emergence from the nymph.

Imago ♂ (in alcohol). Plate XIX., figs. 6*a–g*.

Upper lobes of the eyes red, lower pitchy black; ocelli light-grey; epistome dark-red, four yellow spots on each side, under the ocelli. Thorax pitchy black. Abdomen dark-grey, with lighter median line. Two grey spots on segments 2–6. Fore leg very long and slender, light red-brown spot at each end and at the centre of the femur, the segments marked with blackish-brown; second and third legs similarly marked. Setæ light-grey, with broad black rings at alternate segments, the rings gradually spreading towards the extremity. Wings vitreous, base fulvous; veins brownish-black in marginal and submarginal areas, with cross-veinlets greatly thickened. Marginal and submarginal areas lightly tinged toward extremities. Brownish-grey spot behind the bulla. Length of body, ♂, 10 mm.; length of setæ, 15 mm.; length of wing, 10 mm.; length of fore leg, 15 mm.

Imago ♀. Plate XVIII., figs. 5*a–g*.

Very similar.

ART. XXI.—*A Revision of the* Crustacea Anomura *of New Zealand.*

BY GEO. M. THOMSON, F.L.S.

[*Read before the Otago Institute, 22nd November, 1897.*]

Plates XX., XXI.

IN the "Catalogue of the Stalk- and Sessile-eyed Crustacea of New Zealand," published in 1876, Miers gives a list, with descriptions, of thirteen species of *Anomura*, belonging to nine genera. Of these, *Remipes marmoratus* and *Pagurus imbricatus* do not belong to New Zealand at all, having been collected by Hombron and Jacquinot at Raffles Bay, which is in Northern Australia. *Pagurus pilosus*, also of M.-Edwards, belongs to Dana's genus *Paguristes*. In regard to the remaining species, two of them—*Eupagurus cristatus*, Edw., and *E. spinulimanus*, Miers—have not again been identified, but I retain them here provisionally.

The number of species included in the present list is thirty-five, belonging to sixteen genera.

The Crustacea of this group are not well represented in the seas of New Zealand—at any rate, in the littoral zone, which is the only one which has been investigated up to the present time. In individuals, such species as *Petrolisthes elongatus*

and *Grimothea gregaria*—as it is convenient still to call this form, referred to *Munida*—are enormously abundant; but hermit crabs have not been met with at all freely.

I have had the privilege—thanks to the kindness of Dr. Benham and Captain Hutton—of examining all the species belonging to this group of Crustacea which are preserved in the Otago and Canterbury Museums, and Sir James Hector has kindly sent me specimens from Wellington. I have also to thank Mr. H. Suter, of Christchurch, for intrusting to me all his specimens for examination. In all cases the small amount of material available shows that hermit crabs and their allies are not commonly met with.

With the increase of trawling-vessels it ought soon to be possible to explore the coastal zone to a depth of 50 fathoms or more, and this may disclose a number of forms which are unknown at present.

In the classification adopted I have followed Henderson in the "Report of the *Anomura* collected by H.M.S. 'Challenger,'" 1888. I have not given the synonym where this has already been given by Miers and Henderson, as their works are readily available.

ANOMURA.

DROMIDEA.

Fam. DROMIDÆ, Dana.

Carapace subglobular. Legs of moderate size, cylindrical; 4th and 5th pairs short and (especially the last) subdorsal in position. Eyes capable of retraction into well-defined sockets. The males have the vasa deferentia produced as tubular prolongations from the coxal joints of the 5th pair of legs.

Genus Cryptodromia, Stimpson.

Carapace convex, pubescent. Palate with a slight elevation on each side. Chelipedes with their apices calcareous. All the legs are more or less nodose; the last two pairs are subchelate, the penultimate joint ending in a spiniform process.

Cryptodromia lateralis, Gray. Plate XX., figs. 1 and 2.

Miers, Cat. N.Z. Crust., p. 57, &c.

This species, according to Henderson, ranges from Australia and New Zealand to the coasts of Japan. In Miers's catalogue it is described as from New Zealand (Coll. Brit. Mus.), and Heller (Voy. of the "Novara") obtained it at Auckland.

I have not met with it myself, nor do any specimens appear to exist in any of the museums of the colony. I am

indebted to the authorities of the Australian Museum, Sydney, for Australian specimens, which have enabled me to figure the species.

PAGURIDEA.

Fam. I. PAGURIDÆ, Dana.

Hermit crabs, in which the branchiæ are laminate in form, the central stem bearing two rows of flattened leaflets. All inhabit shallow seas.

1. First and second abdominal segments without genital	
a. Fourth pair of legs chelate.	
Front with rostral projection; ocular peduncles slender; chelipedes subequal	1. *Clibanarius.*
b. Fourth pair of legs subchelate.	
Front with rostral projection.	
Chelipedes unequal, the *right* usually the largest	2. *Eupagurus.*
Chelipedes subequal	3. *Aniculus.*
Chelipedes unequal, the *left* the largest	4. *Stratiotes.*
2. First and second abdominal segments with genital appendages (the first segment only in the female)	

Fam. II. PARAPAGURIDÆ, Smith.

Hermit crabs, in which the branchiæ consist of a central stem bearing two rows of rounded filaments, gradually decreasing in size towards the apex. All inhabit very deep sea.

Chelipedes stout, very unequal, the right larger; males without a protruded vas deferens, and having genital appendages on the first two abdominal segments	1. *Parapagurus.*
Chelipedes slender, the right slightly larger; males with a protruded vas deferens, and without the genital appendages on the first two abdominal	2. *Pagurodes.*

Genus incertæ sedis.

Carapace produced into a long rostrum; abdomen bearing one pair of appendages on its anterior portion, furnished with plates at its posterior extremity. Living among Algæ, and not seeking the protection of an empty shell	*Porcellanopagurus.*

Genus 1. CLIBANARIUS. Dana.

Front acute in the middle. Ocular peduncles slender, the basal scales small and close together. Antennal acicle short, the flagellum naked. Chelipedes similar, subequal; hand small, fingers opening horizontally, excavated internally and horny at the tips. Ambulatory legs smooth, often with longitudinal colour-markings, penultimate pair chelate.

1. Clibanarius cruentatus, Edwards.

1848. *Pagurus cruentatus*, M.-Edw., Ann. Sc. Nat., x., p. 62.
1876. *Clibanarius cruentatus*, Miers, Cat. N.Z. Crust., p. 67.
1885. *Clibanarius cruentatus*, Filhol, Mission de l'île Campbell, p. 424, pl. 42, fig. 1.

This species was found in the northern portion of New Zealand by Quoy and Gaimard, but was unknown to Miers, who gives a very brief diagnosis of it from Milne-Edwards.

Filhol (*l.c.*) has given a good representation of this species from the original specimens, and has given the following description of it: "This species is very remarkable on account of its general colour, which is a blood-red, dotted over with a great number of little white spots. The front is angular in its anterior portion, and the front border of the carapace hides the ophthalmic segment. The outer antennæ are long and naked; the portion of the joint supporting them and corresponding to the palp is feebly developed, and covered with hairs on its outer margin. The arms are small and equal. The carpos is much reduced, and presents a somewhat strong spine at the anterior extremity of its upper margin. The hand is furnished with spines on the whole of its upper edge and along the whole extent of its outer face. All these very acute prominences are of a white colour, and they give insertion at their base to some hairs of a reddish colour. The ambulatory feet are not spinous, and they are covered with hairs inserted in little bunches on the white spots. The dimensions are—Length, 20 mm.; breadth, 5 mm." Filhol does not seem to have collected this species, nor have I heard that any one else has seen it in New Zealand.

2. Clibanarius barbatus, Heller.

Miers, Cat. N.Z. Crust, p. 67.

This species occurs in the British Museum, apparently from Auckland, and was found in that locality by Heller. I have not seen it, nor does it appear to have been collected by any one else since Heller's time.

In the report on the "Challenger" *Anomura*, Henderson, speaking of *Paguristes subpilosus*, says (p. 78), "A New Zealand species of *Clibanarius*—the *C. barbatus* of Heller—apparently presents many points of resemblance, but the dactyli of the ambulatory limbs are described as scarcely shorter than the corresponding propodi." It is to be regretted that he did not compare the specimens which, according to Miers, occur in the British Museum.

Genus 2. Eupagurus, Brandt.

Front usually slightly rostrate. Ocular peduncles slender, with small basal scales. Antennal acicle elongated and

slender; flagellum long and naked. Chelipedes unequal, the right usually the largest; fingers closing vertically. Penultimate pair of legs subchelate.

A. Front of carapace produced to an acute angle on the median line.

Propodos of right chelipede—

a. Without hairs.

Outer face furnished with six rows of rounded tubercles	1. *E. novæ-zealandiæ.*
Thickly covered with conical tubercles, lower margin curved and denticulated	2. *E. kirkii.*
Propodos fastened nearly at right angles to carpos, surrounded by a continuous denticulated crest ..	3. *E. cookii.*
Surface nearly quite smooth.	
Propodos of left chelipede ovoid and granular	4. *E. hectori.*
Propodos of left chelipede with an acute spinose central crest ..	5. *E. lacertosus.*

b. More or less covered with hairs.

Outer surface with six longitudinal rows of tubercles	6. *E. traversi.*
Outer surface granular, margins slightly toothed	7. *E. stewarti.*

B. Front of carapace not produced on median line.

Propodos of right chelipede—

Broad, covered on outer side with scattered tubercles among matted pubescence, especially on median elevation ..	8. *E. rubricatus.*
With two lines of spinules among short, dense hair	9. *E. spinulimanus.*
With six rows of round-topped tubercles buried in thick hair	10. *E. edwardsi.*

C. Incertæ sedis.

a. Chelipedes very short, propodos of right chelipede surrounded by a single denticulated crest	11. *E. campbelli.*
b. Right chelipede with carpos completely spinous, propodos surrounded on the upper face by three denticulated crests ..	12. *E. thomsoni.*
c. Carpos of right chelipede with thin upper and lower margins, having the form of a denticulated crest	13. *E. cristatus.*

1. **Eupagurus novæ-zealandiæ**, Dana. Plate XX., figs. 3–5.

1843. *Pagurus cristatus*, Dieffenb. N.Z., ii., p. 266.
1847. *Pagurus cristatus*, List Crust. Brit. Mus., p. 59.
1852. *Bernhardus novi-zealandiæ*, Dana, U.S. Expl. Exped., xiii., Crust., part i., p. 440, pl. xxvii., fig. 1.
1876. *Eupagurus novæ-zealandiæ*, Miers, Cat. N.Z. Crust., p. 63.
1885. *Eupagurus novæ-zealandiæ*, Filhol, Miss. de l'île Campbell, p. 412.

Front of carapace with the median prolongation and the lateral angles subequally produced; back with a few scattered tufts of hairs.

Ocular peduncles slender, about three-fourths as wide as the carapace in front; basal scale produced on the inner side into a short lobe, ending in several small spines.

Antennules with peduncle reaching to or slightly exceeding the ocular peduncles.

Antennæ with peduncle subequal to the ocular peduncles; basal joint produced on its hairy outer side to about the middle of the penultimate joint, obtusely toothed at its apex, and bearing at its antero-internal angle a short acute spine; acicle slightly shorter than ocular peduncles, somewhat curved outwards, and with about five tufts of hair on the inner edge; flagellum reaching to end of right chelipede.

The right chelipede has the meros nearly smooth, but with a small fringe of hairs on its upper distal margin; carpos somewhat rounded above, broadening distally, with numerous conical tubercles (in small specimens only granules) more or less arranged into five longitudinal rows, and mixed—especially towards the outside—with a few tufts of short hairs. Seen from the side the meros is nearly quadrangular, while the carpos is deeply triangular, the upper face forming the base; its outer side is smooth, and the distal extremity is margined by a row of rounded tubercles. On the inner side the carpos is produced into a pyramidal tubercle. The propodos is about equal in width to the carpos, is ovate in form, nearly quite glabrous, and is covered with rounded tubercles, forming with the margins six longitudinal rows; of these, the 2nd from the upper margin is continued into a strong ridge-like row of tubercles on the dactylos, the 3rd and 4th unite to form a single ridge on the immobile finger, the 5th is very short; the fingers are strongly toothed on the inner side.

The left chelipede is much smaller than the right, and is somewhat slender; the carpos bears a single row of spines on its upper edge, with numerous tufts of hairs; the propodos, which is scarcely larger than the dactylos of the right chelipede, has about two rows of rounded tubercles on its upper edge, and a few tufts of hairs on its inner edges.

The ambulatory legs are long, furnished with numerous tufts of coarse hairs, especially on the margins and towards the extremities. In the posterior pair the hairs on the dactyli tend to assume the appearance of a thick fringe on either margin.

The colour of large specimens is dark-grey, greyish-green, or brown, often relieved with blue at the base of the joints of the six anterior legs, the tips of the antennæ, and the granules on the chelipedes.

Size: Length of body, 62–77 mm.; length of carapace alone, 13–14 mm.; length of ocular peduncles, 7–8 mm.; length of right chelipede, 45–60 mm.; length of left chelipede, 28–37 mm.; length of 3rd leg, 40–65 mm. The last measurement is taken from a rather large specimen from Stewart Island. Miers gives the length as from $1\frac{1}{2}$ in. to 2 in., which is a common enough size for shallow-water specimens; but Filhol is wrong when he makes use of relative size as a distinction between this species and his *E. edwardsi.* Many of my Dunedin specimens do not exceed about 20 mm. in length.

Distribution.—New Zealand and Falkland Islands.

Habitat.—This species appears to be common in both Islands. Dana found it in the Bay of Islands, and Heller at Auckland. I have numerous specimens from Wellington (*Sir James Hector*), Otago Harbour, and Stewart Island, where Filhol also obtained it.

2. Eupagurus kirkii, Filhol. Plate XX., figs. 8–10.

1885. *Eupagurus kirkii,* Filhol, Miss. de l'ile Campbell, p. 416, pl. li., fig. 5.

Front of carapace produced on the median line into an acute short rostrum; angular projections on each side hardly defined. Back of carapace almost quite glabrous.

Ocular peduncles slender, about as long as the width of the carapace in front; basal scale produced into a small nearly naked tooth on the inner margin.

Antennules with the peduncle one-fourth shorter than the ocular peduncles.

Antennæ with the peduncle scarcely longer than the ocular peduncle; outer spine of basal joint reaching to half the length of, and acicle as long as or slightly exceeding, the ocular peduncles; flagellum scarcely as long as right chelipede.

Chelipedes very unequal, more or less covered with fine scattered hairs.

Right chelipede with meros compressed, its upper margin slightly ridged but smooth, its upper distal edge furnished with a short spine and a few fringing hairs, below it is broadened and excavated to receive the next joint, its outer and inner lower margins spinose; carpos rather rounded above and broadening distally, its inner upper margin spinose, with numerous short spines scattered over the rather pubescent upper surface; propodos quite glabrous on its outer face, which is thickly covered with conical tubercles, upper margin somewhat thin and crest-like, two rather prominent tubercular ridges are on the outer face, while the lower margin forms

a curved and strongly denticulated crest; the short dactylos has tubercles similar to those on the propodos.

Left chelipede more hairy and much smaller than the right; carpos with a few spines on its upper margin; these become very strong at the distal end; propodos with a very strongly serrated crest along the outer side, and another much less produced and curved along the lower margin; the dactylos is two-thirds as long as the propodos, is slightly curved, and only impinges against the latter at its apex.

Ambulatory legs long and sparingly furnished with hairs, the dactyli of both pairs furnished on their lower edge with a row of pectinate spines.

Colour: My spirit specimens are more or less striped and marked with red and white, the markings being very prominent in longitudinal lines on the ambulatory legs.

Size: Length of body, 29 mm.; length of carapace alone, 6 mm.; length of ocular peduncles, 4 mm.; length of right chelipede, 25 mm.; length of left chelipede, 20 mm.; length of 3rd leg, 31 mm.

Distribution.—Only found in New Zealand.

Habitat.—At Massacre Bay (*Filhol*), Dunedin, and Stewart Island.

3. **Eupagurus cookii, Filhol.** Plate XX., figs. 11–13.

1885. *Eupagurus cookii*, Filhol, Miss. de l'île Campbell, p. 417, pl. li. fig. 2.

Front of carapace produced on the median line into an acute short rostrum, the angular projections on each side hardly defined. Back of carapace with a very few tufts of hairs.

Ocular peduncles slender, scarcely dilated at the end, about as long as the width of the carapace in front; basal scale produced into a small nearly naked tooth on its inner margin.

Antennules having the peduncles one-fourth shorter than the ocular peduncles.

Antennæ with peduncles longer than the ocular peduncles, last joint long and naked; basal joint produced on its outer side to about the length of the penultimate joint; acicle reaching to the end of the ocular peduncles; flagellum reaching to the end of the right chelipedes.

Chelipedes very unequal in size.

Right chelipede with meros compressed and rounded above, below it is hollowed out to receive the flexion of the succeeding joint, and both its outer and inner lower margins are fringed with a close-set row of spines; carpos much compressed, its upper margin produced into a very prominent spinose crest, the outer side rounded and furnished with a

few long hairs, the inner side nearly smooth; the propodos is articulated to the carpos almost at right angles, and perhaps is thus intended to close the aperture of the shell in which the animal lives, the whole surface is covered with rounded granulations. The margins form a very prominent continuous denticulated crest, the upper (inner) margin being nearly straight from its base to the end of the mobile finger, while the outer is nearly semicircular. A median longitudinal ridge on the outer face and a second near its inner margin produce a deep hollow between them.

Left chelipede very thin and much compressed; the meros closely resembles that of the right side; the carpos is not distinctly crested, but its upper edge bears a row of curved spines; the propodos has its upper margin greatly produced into a thin denticulated crest which passes outwards and downwards in a strong curve; the nearly straight dactylos is about three-fourths as long as the propodos, and is closely applied along its lower edge.

Ambulatory legs with very few hairs, dactyli in both pairs, with a row of sharp spines along the lower margin.

Size: Length of body, 27 mm.; length of carapace, 6 mm.; length of ocular peduncles, 3·5 mm.; length of right chelipede, 21 mm.; length of left chelipede, 18 mm.; length of 3rd leg, 20 mm.

Distribution.—Only found in New Zealand.

Habitat.—Cook Strait (*Filhol*); on Wanganui Bar, 10–20 fathoms (*S. H. Drew*); Dunedin; Stewart Island, 8 fathoms.

A mutilated specimen of what I take to be an immature example of this species was sent me by Captain Hutton. It was found in a worm-tube, and was taken at a depth of 110 fathoms, at Bounty Island. The length of the right chelipede was barely 3 mm.

4. **Eupagurus hectori**, Filhol.

1885. *Eupagurus hectori*, Filhol, Miss. de l'ile Campbell, p. 419, pl. li., fig. 1.

The front is spinous at its anterior portion, and the lateral margins of the anterior portion of the carapace are rounded.

Antennæ having the acicle greatly developed; flagellum long (in the figure they are shown as greatly exceeding the chelipedes).

Right chelipede has the "carpos triangular, with the base below. Its outer and inner faces are somewhat strongly convex; its upper edge is thick, almost rounded. This latter portion has, as in the outer face of the carpos, some slightly defined granulations. The hand is strong, its upper margin very short, while its extended lower edge is regularly convex. The whole external surface of the hand as well as the carpos

is glabrous." Dactylos with some obtuse denticulations along its lower or inner border, with short stiff hairs between.

Left chelipede has the carpos with an enlarged upper edge bearing two series of tubercles and tufts of hairs; propodos ovoid, its upper surface and that of the dactylos granular.

Ambulatory feet long, with a few hairs on the upper and lower edges of the joints; carpos of the anterior pair spinous on the upper edge.

Abdomen without plates.

Length of the male, 20 mm.; breadth of carapace, 5 mm.

Habitat.—Filhol states that the species occurs somewhat rarely along all the coasts of the colony, but becomes more abundant towards the south, especially in Stewart Island.

I have recently received from Stewart Island a few immature specimens which appear to belong to this species.

5. **Eupagurus lacertosus**, Henderson.

1888. *Eupagurus lacertosus*, Henderson, Rep. Anom. Chall. Exped., p. 63, pl. vi., fig. 7.

E. lacertosus, var. *nana*, *l.c.*, p. 64, pl. vii., fig. 1.

Median frontal process of carapace prominent and acute, lateral projections less marked, each tipped by a small spine.

Ocular peduncles moderately slender.

Antennules with the second joint of the peduncle subequal with the eye-stalk.

Antennæ having the peduncles exceeding the eye-stalks by almost the whole length of the ultimate joint; acicle long and slender.

Chelipedes unequal, both relatively of large size, with a granular and spiny surface.

Right chelipede with the upper surface of the carpos covered with tubercular spines, inner border furnished with a row of acute spines the two anterior of which are bifid; propodos about one-third longer than carpos, upper surface granular, leaving two oblique tubercular ridges.

Left chelipede with two rows of acute spines on its upper edge, and a large bifid spine near the centre of the anterior and upper border; propodos with an acute central carina, armed with tubercular spines.

Size: Length of body, 33 mm., but Australian forms taken from shallower water, and distinguished by Henderson as var. *nana*, do not exceed 12 mm. in length.

Distribution.—South-east coast of Australia and Tasman Sea.

Habitat.—In the Tasman Sea, to the west of Cook Strait, near the Australian cable line, in 275 fathoms.

I do not know this species.

6. **Eupagurus traversi**, Filhol. Plate XXI., figs. 1–3.

1885. *Eupagurus traversi*, Filhol, Miss. de l'ile Campbell, p. 422, pl. l., figs. 5 and 6.

Front of carapace produced into an acute point on the median line, lateral angles not so well defined. Back of carapace almost destitute of hairs.

Ocular peduncles rather less than width of front of carapace, slender; basal scale rather slightly developed, produced on the inner side into a small ciliated spine.

Antennules with the peduncles reaching only a very short way beyond the eye-stalks.

Antennæ having the peduncles reaching slightly beyond the ocular peduncles; basal joint with a minute spine on the inside, and having the outer spine reaching half-way to the extremity of the eye-stalks, acicle barely reaching to the extremity of the eye-stalks; flagellum not reaching to end of the right chelipede, joints coloured red and white in alternate groups.

Chelipedes very unequal.

Right chelipede with the meros rounded and smooth above, with a single spine on the distal end of the upper margin, and a fringe of small spines on the lower distal border; carpos short, narrow, but widening distally, upper and outer surface with a very few spines buried among long hairs; propodos slightly wider than carpos, with six rows of spinose tubercles on the outer face buried among long hairs, inner face rugose, almost free from hairs; fingers with very strong teeth on their opposed surfaces.

Left chelipede narrow and much compressed; meros and carpos very hairy, each with two closely approximated rows of tubercles on the upper margin; fingers curved, with strong terminal teeth.

Ambulatory feet rather hairy, especially towards the extremities; second pair with a single spine at the extremity of the upper edge of the carpos; dactyli ending in very acute dark-coloured claws.

Size: Length of body, 27 mm.; length of carapace, 6 mm.; length of ocular peduncle, 4 mm.; length of right chelipede, 15 mm.; length of left chelipede, 12 mm.; length of 3rd leg, 19 mm.

Distribution.—Confined to New Zealand.

Habitat.—Cook Strait (*Filhol*), Kenepuru Sound (*J. McMahon*), Lyttelton, Dunedin, Stewart Island (*Filhol*).

Filhol states that "the ophthalmic segment is almost completely hidden under the anterior margin of the carapace," and states that this character, *inter alia*, serves to distinguish the species from *E. edwardsi* and *E. novæ-zealandiæ*. In

every other respect his description agrees so well with the numerous specimens in my possession that I have no doubt of the identity of my species with his; but the character does not seem to me at all a conspicuous one, nor do I attach any importance to it from a classificatory point of view.

7. **Eupagurus stewarti**, Filhol.

1885. *Eupagurus stewarti*, Filhol, Miss. de l'île Campbell, p. 418, pl. li., fig. 3.

Front of carapace with three angular projections, that in the median line prominent.

Ocular peduncles long; eye a little enlarged transversely.

Antennæ long; flagellum covered with fine long hairs.

Right chelipede rather strongly developed; upper face of carpos almost flat, inner edge toothed and spinous, outer granular, the whole surface bearing a few scattered slightly elongated hairs; propodos almost quadrilateral, and very different from that of any other New Zealand species, its upper and lower margins slightly toothed and whole upper surface granular, and bearing a few hairs; dactylos evenly crenulated and hairy along the upper margin, which is much extended, and bent sharply at its anterior rounded extremity.

Left chelipede with the carpos triangular, and furnished on the anterior two-thirds of its upper margin with somewhat strong spines.

Abdomen without plates.

Size: Length of the body (in the male), 20 mm.; breadth of the carapace, 4 mm.

Distribution.—New Zealand.

Habitat.—Stewart Island (*Filhol*).

I do not know this species.

8. **Eupagurus rubricatus**, Henderson.

1888. *Eupagurus rubricatus*, Henderson, Rep. Anom. Chall. Exped., p. 69, pl. vii., fig. 4.

Front of carapace smooth, frontal projections scarcely indicated, median obtusely rounded.

Ocular peduncles rather stout, with the corneæ dilated; basal scales with the terminal portion slender and acuminate.

Antennules with the distal end of the second joint of the peduncle not reaching the end of the eye-stalk.

Antennæ have the peduncle slightly exceeding the eye-stalk; acicle reaching nearly to the end of the peduncle, basal joint with a minute spine on its inner margin, outer prolongation spinulous, and reaching as far as distal end of the penultimate joint.

Chelipedes unequal, and of moderate size.

Right chelipede with a single spine on the distal end of the upper border; carpos with a number of conical spines scattered over the inner half of the pubescent upper surface; propodos much broader than, and nearly twice as long as, the carpos, upper surface covered with a matted pubescence, among which are scattered white rounded tubercles, especially on an irregular central elevation, inner and outer margins fringed with long hairs and a row of blunt spines; dactylos with several rows of rounded tubercles.

Left chelipede with a double row of spines on the upper surface of the carpos; propodos placed at an angle to the carpos, outer border strongly convex, armed with strong spines, surface pubescent and tubercled as in the right chelipede; dactylos densely pubescent on the upper surface, ending in a minute horny claw.

Ambulatory legs with the carpi moderately spiny in front, dactyli longer than the propodi, each ending in a yellow horny claw, borders fringed with delicate horny spines, especially towards the apex.

Size: Length of carapace, 13 mm.; length of right chelipede, 28 mm.; length of left chelipede, 21 mm.; length of 3rd leg, 36 mm.; length of ocular peduncle, 5·8 mm.

Distribution.—New Zealand.

Habitat.—About sixty miles east-north-east of East Cape, in 700 fathoms.

Only a single mutilated specimen (abdomen wanting) was in the "Challenger" collection.

9. **Eupagurus spinulimanus**, Miers.

1876. *Eupagurus spinulimanus*, Miers, Ann. Mag. Nat. Hist., ser. 4, xvii., p. 222.

1876. *Eupagurus spinulimanus*, Miers, Cat. N.Z. Crust., p. 63, pl. i, fig. 6.

1885. *Eupagurus spinulimanus*, Filhol, Miss. de l'ile Campbell, p. 423.

Miers characterizes this species as having the front of the carapace without a median projection, the flagella of the antennæ with series of three and five joints alternately annulated with red and white, the chelipedes clothed with short dense hair, with the carpos and propodos spinulous.

Right chelipede with a series of larger spines on the upper inner margin of the carpos; propodos with the spinules arranged in two longitudinal lines.

Ambulatory legs hairy, hairs more dense on the dactyli, which are longer than the propodi; propodi of second pair with a row of spinules on the upper margin.

I have never met with this species, nor does Filhol appear to have come across it.

10. **Eupagurus edwardsi,** Filhol. Plate XX., figs. 6, 7.

1885. *Eupagurus edwardsi,* Filhol, Miss. de l'ile Campbell, p. 412, pl. lii., figs. 1 and 2.

Front of carapace sinuate, not at all produced on the median line, but with the angular projection at the sides fairly pronounced. Tufts of hair on the back and sides of the carapace.

Ocular peduncles subequal with width of the front of the carapace, slender, hardly dilated above; basal scales slightly developed, produced on the inner side into a spine furnished with hairs on both margins.

Antennules having the peduncle slightly exceeding the eye-stalks.

Antennæ with peduncle scarcely reaching the apex of the eye-stalk; basal joint short, with a very small spine on the inner side, and produced on the outer side into a hairy spine, which is almost as long as the penultimate joint of the peduncle; acicle rather shorter than ocular peduncle, and with tufts of hair on the inner margin; flagellum not reaching to end of the right chelipede, with the joints coloured red and white in alternate series of two or three up to seven.

Chelipedes very unequal.

Right chelipede having the meros compressed, its upper distal margin ending in a spine and a few fringing hairs, the outer side nearly smooth, and having a few spines and hairs on the lower margin; carpos widening distally, its inner face bearing a few hairs, its outer covered with thick tufts of hairs; the upper edge is sharply defined by seven or eight strong spines, while numerous shorter ones are mingled with the hairs on the upper half of the outer face of the joint; the propodos is much broader than the carpos, and is covered with a thick felt of hairs, which are produced like fringes on the margins; among these hairs there are placed about six rows of tubercles (counting the margins), of which the second forms a ridge which continues along the outer side of the dactylos, and the fourth also forms a similar ridge along the immobile finger (these tubercles are usually pink or violet in colour, are rounded above, and stand on a contracted pedicel); the inner face of the propodos is nearly quite smooth, the inner (opposed) faces of the fingers are strongly toothed.

The left chelipede has a somewhat similar meros, also with a single spine on its upper distal margin; the carpos has two rows of spines on its upper surface, with numerous tufts of hairs, which become very dense towards the distal end; the propodos is much compressed, oval in form, thickly covered with a felt of hairs forming a dense fringe on its

lower and outer margin, and bearing three rows of tubercles on the outer face—one central and two marginal, the inner face is furnished with scattered tufts of long hairs; the dactylos is nearly straight, and is about half as long as the propodos.

The ambulatory limbs are furnished on both margins of the joints with tufts of hairs, which become very dense on the dactyli, at the extremities of which they are mingled with acute spines; the carpos of the second pair also bears a row of spines on its upper edge.

Size: Length of body, 77 mm.; length of carapace, 14 mm.; length of ocular peduncle, 11 mm.; length of right chelipede, 55 mm.; breadth of right chelipede, 14 mm.; length of left chelipede, 43 mm.; length of 3rd leg, 56 mm.

Distribution.—New Zealand.

Habitat.—Stewart Island (*Filhol*); Dusky Sound (*R. Henry*); Ocean Beach, Dunedin.

I have only one specimen from each locality, and that from the last named is only about one-third the size of the one described.

11. **Eupagurus campbelli**, Filhol.

1885. *Eupagurus campbelli*, Filhol, Miss. de l'ile Campbell, p. 421, pl. lii., fig. 5.

Filhol says of this species: "It seems to me very different from all the forms as yet described from other parts of New Zealand. It is characterized by the form of its arm, which is remarkably short. The carpos of the right chelipede is swollen and considerably enlarged towards its anterior extremity. The propodos is short and massive, its outer or upper face surrounded by a tolerably well marked but slightly prominent crest. The fingers are very slightly developed, and are furnished with slight denticulations on their margins. The outer border of the carpos of the left chelipede is straight at its origin, but soon bends outwards and becomes strongly convex; the propodos is much reduced, is triangular in form, and acute at its apex."

Habitat.—Perseverance Bay, Campbell Island, 10–12 fathoms.

I do not know the species.

12. **Eupagurus thomsoni**, Filhol.

1885. *Eupagurus thomsoni*, Filhol, Miss. de l'ile Campbell, p. 423, pl. li., fig. 6.

Filhol very briefly describes this species as follows: "The right chelipede is very strong; its carpos is completely spinous. The propodos presents on its upper face a crest furnished with obtuse and close denticulations; this crest is continued an-

teriorly till it joins the outer or lower margin of the propodos. Two other crests, less prominent but furnished with finer and more pointed tubercles, surround the upper face of the propodos. The inner edge of this part is strongly spinous. The inner edge of the carpos of the left chelipede is very convex, lamellar (?), and toothed."

Habitat.—Cook Strait.

I do not know the species.

13. **Eupagurus cristatus**, M.-Edw.

1836. *Pagurus cristatus*, M.-Edw., Ann. Sci. Nat., ser. 2, vi., p. 269.
1837. *Pagurus cristatus*, M.-Edw., Hist. Nat. Crust., t. ii., p. 218.
1876. *Eupagurus cristatus*, Miers, Cat. Crust. of N.Z., p. 62.
1885. *Eupagurus cristatus*, Filhol, Miss. de l'ile Campbell, p. 412.

Front margin of carapace prominently produced on the median line.

Chelipedes granulous or slightly spinous; carpi having the upper and lower margins in the form of a denticulated crest; propodi slightly compressed, with one or two thin prominent ridges.

The description given by Milne-Edwards is too imperfect for identification, and I do not know the species, nor could Miers distinguish it. Yet Filhol says, "This species is not very common in New Zealand. I have found it in Cook Strait, and ranging as far south as Stewart Island." It is very unfortunate that he did not give a description and figure of it, for it is quite unknown to other carcinologists.

Genus 3. Aniculus, Dana.

Front acute in the middle. Ocular peduncles long and slender. Antennal acicle short and stout, the flagellum naked. Chelipedes very short, subequal; fingers opening vertically, excavate internally, black and horny at the tips. Antepenultimate pair of ambulatory legs subcheláte.

1. **Aniculus typicus**, Dana.

Miers, Cat. N.Z. Crust., p. 64.

This well-marked species occurs, according to Miers, on the shores of various islands in the Pacific, and on the coast of Australia. It was obtained by Heller at Auckland, but does not seem to have been met with since in New Zealand. I have a specimen collected at Funafuti, which was kindly forwarded to me by the authorities of the Australian Museum (Sydney).

Genus 4. STRATIOTES, nov. gen.

Front with a distinct rostral projection. Ocular peduncles long and slender, the basal scales small and situated close together. Antennal acicle short and straight; flagellum ciliated. Chelipedes unequal, the left larger; fingers moving vertically, scarcely excavated. Penultimate pair of legs subchelate.

This genus appears to be allied to *Diogenes*, Dana, but the latter is distinctly characterized by the movable rostriform process situated between the ocular peduncles.

Stratiotes setosus, nov. sp. Plate XXI., figs. 4–6.

Pagurus setosus, Filhol, Miss. de l'ile Campbell, p. 490, pl. xlix., figs. 5–7.

Carapace with the front less than half its width, slightly produced into an angular point on the median line; lateral angular projections very slight, but defined by a short spine; sides of the front with a row of minute spinules; surface with tufts of hairs, especially on the sides.

Ocular peduncles straight, cylindrical, quite smooth, nearly as long as the whole width of the carapace; basal scale produced on its inner side into a short spinose lobe.

Peduncle of the antennules slightly longer than the ocular peduncles.

Peduncle of the antennæ not reaching to the end of the ocular peduncles; ultimate joint nearly naked; basal joint transverse, with a minute spine on its inner edge and produced on the outer edge; acicle lanceolate, very acute, reaching beyond the penultimate joint of the peduncle, with one or two spines near its base and numerous hairs on its surface and margins; flagellum reaching to the extremity of the right chelipede, furnished with a thick fringe of setæ.

Chelipedes very unequal, left much the larger.

The right chelipede has the meros sharply keeled above, ending in a sharp spine, outer and inner faces nearly quite smooth. The rest of the limb is covered, especially on its upper edge and outer side, with long densely tufted hairs, while the inner side is nearly smooth. The carpos, propodos, and dactylos are subequal in length, and their upper edge bears a row of strong spines, which diminish in size towards the end of the finger.

The left chelipede is very strong. The meros has a few strong spines on its distal upper edge and on both its lower margins. The carpos is short, with a rounded upper and outer side, furnished with numerous spines, which are especially strong on the upper margin, and are more or less hidden by short thick hairs, which are especially numerous towards

the distal end. The propodos and dactylos are thickly covered on the outside with conical protuberances, which on the basal half are buried in thick hairs; both fingers are quite naked on the inside.

Ambulatory limbs long and very hairy, especially on the margins of the joints.

I cannot specify the colour of the species, all my spirit specimens being of a uniform yellowish-brown colour.

Size: Length of body, 70 mm.; length of carapace alone, 21 mm.; length of ocular peduncles, 10 mm.; length of right chelipede, 29 mm.; length of left chelipede, 39 mm.; length of 3rd leg, 52 mm.

Habitat.—I have received this species from Wellington (*Sir James Hector*), from Lyttelton (*Captain Hutton*), and from Cook Strait (*Filhol*).

Filhol (*l.c.*) has figured this species on plate 49, figs. 5 to 7, and at p. 490 briefly describes it under the name of *Pagurus setosus*, as follows: "I thought at first of referring to *Pagurus pilosus* a species of Crustacean of which I had gathered two specimens in Cook Strait. I have figured one of them somewhat enlarged, but further examination showed me that I was wrong in the first instance, and that the form of Crustacean which I had found was identical with a *Pagurus*, also occurring in New Zealand, and figuring under the name of *Pagurus setosus* in the collections of the Paris Museum. The description of this species, which appears to be rare, has never yet been given. The outer antennæ are long, and are covered on their external margin with long and fine hairs. The upper and outer margins of the hand present a series of large tubercles. The feet are furnished on the anterior and posterior margins of the different articulations with extremely delicate long hairs. The specimen which I have figured is magnified three times."

Genus 5. Paguristes, Dana.

Front with the rostral projection prominent and often acute. Ocular peduncles remarkably long and slender, the ophthalmic scales of moderate size, and separated by a considerable interval. Antennules long. Antennal acicle robust, the flagellum usually short and ciliated. Chelipedes subequal, or of equal size, the fingers moving in a horizontal plane and calcareous or corneous at the tips. Penultimate pair of legs not chelate. Abdomen of the male with the first two segments bearing each a pair of appendages; in the female a single pair present on the first segment and a membranous oviferous sac borne on the left side of the second, third, and fourth segments. (*Hend.*)

1. **Paguristes pilosus,** M.-Edwards.

Pagurus pilosus, Milne-Edwards. (See Miers's Cat., p. 66.)

Miers has reproduced Edwards's description in the Cat. N.Z. Crust. The original specimens are in the collections of the Paris Museum. One specimen was apparently found among the "Challenger" *Anomura*, near Wellington, in 10 fathoms. Henderson says of it, "A male specimen, from which the left chelipede and ambulatory limbs have disappeared, apparently belongs to this species. The hairs on the chelipede and other parts are characteristically branched."

I do not know the species.

2. **Paguristes subpilosus,** Henderson.

Rep. Anom. Chall. Exped., p. 77, pl. viii., fig. 2.

Two specimens were found to the west of New Zealand, near the line of the Australian cable, at a depth of 150 fathoms (lat. 39° 32′ S.; long. 171° 48′ E.). These are the only specimens known.

Fam. II. PARAPAGURIDÆ, Smith.

Genus 1. PARAPAGURUS, S. J. Smith.

The generic characters are given very fully in the Chall. *Anomura*, p. 85.

Parapagurus latimanus, Henderson.

Rep. Anom. Chall. Exped., p. 91, pl. x., fig. 2.

A single male specimen was dredged in Cook Strait, near Wellington, at a depth of 10 fathoms.

I do not know the species.

Genus 2. PAGURODES, Henderson.

Pagurodes inarmatus, Henderson.

Rep. Anom. Chall. Exped., pl. x., fix 5.

Five specimens were obtained by the trawl from a depth of 1,100 fathoms, at a point about sixty miles east of Cape Turnagain. The same species was obtained off Marion Island, far to the south-east of Cape Colony, at a depth of 1,375 fathoms.

Genus incertæ sedis.

PORCELLANOPAGURUS, Filhol.

The only species is described as below by Filhol, but no generic character has been published.

Porcellanopagurus edwardsi, Filhol.

Filhol, Miss. de l'ile Campbell, p. 410, pl. xlix.

The following description is translated almost literally

from the original description: "I gathered this species at Campbell Island, at depths of from 4 to 5 metres, and on the coast of Stewart Island, under similar conditions. It is in form a very remarkable Crustacean, combining, as it were, the characters of the *Porcellanidæ* with those of the *Paguridæ*. It lives in the midst of Algæ, and does not seek, like the latter animals, a place of shelter in abandoned shells. The carapace is semi-oval in shape, and ends in front in a pointed rostrum, which is wide at its base and slightly convex on the sides. The upper margin of the orbit is smooth and raised a little behind. The ocular peduncles extend a little beyond the apex of the rostrum. Almost immediately behind the outer angle of the orbit the edge of the carapace carries two spines, the first being much smaller than the second, which is flattened and very convex on its outer edge. Behind this projection, about 1 mm. from its base, there is placed a much stronger, more distinct spine, which is obtuse at its apex. In front of it is a very small tubercle, which makes a slight projection on the outer border of the carapace. Behind this spine there is a second, which projects transversely outwards and backwards. Its posterior edge is straight, the anterior convex. The apex, whether simple or bifid, is always thickly furnished with fine hairs (*mousse*). Behind this projection the edge of the carapace is straight, and is continued back as far as the articulation of the abdomen. The dorsal surface of the carapace is everywhere covered with fine granulations. The abdomen is somewhat membranous, translucid, and only furnished with plates at its posterior extremity. It bears, in the anterior portion, a pair of short and slender feet. The anterior antennæ are as long as the ocular peduncles, and are terminated by a bunch of hairs. The outer antennæ are very long and slender. The first pair of feet are strongly granular, and the outer and inner faces of the hand and of the fingers are covered with fine tufts of hairs arranged longitudinally. The following pairs of feet are covered with somewhat fine granulations, which on the anterior margin of the 3rd and 4th joints are produced into small spines. The last joint ends in a hooked claw, and its posterior margin bears fine short hairs along its whole length. In the largest specimens collected by me the carapace measures 13 mm. in length and 11 mm. in width."

GALATHEIDEA.

Fam. PORCELLANIDÆ, Henderson.

Carapace broadly ovate, smooth, regions faintly defined; front usually trilobed, processes never of great length. Chelipedes broad and often flattened; ambulatory limbs robust and of moderate length. Antennules concealed; antennal

peduncle directed backwards. External maxillipedes with the ischium broad and meros provided with a prominent internal lobe. Abdomen small, bent under the thorax, to which it is closely applied; females with two (or three) pairs of slender uniramous ovigerous appendages on the 4th, 5th (and 3rd) segments; males with one pair of genital organs on 2nd segment.

I. Basal joint of antennal peduncle short, partially concealed in the orbital cavity, not reaching the superior margin of the carapace.
  a. Sides of rostrum entire, lateral margins of carapace with a single post-ocular spine, or smooth .. .. 1. *Petrolisthes.*
  b. Sides of rostrum spinose, lateral margins of carapace spinose .. .. 2. *Petrocheles.*

II. Basal joint of antennal peduncle forming an acute and somewhat flattened projection external to the orbit, and joined to the margin of the carapace, second joint placed at some distance from the orbit .. .. 3. *Porcellana.*

Genus 1. PETROLISTHES, Stimpson.

1858. *Petrolisthes*, Stimpson, Proc. Acad. Nat. Sci. Philad., p. 65.
1876. *Petrolisthes*, Miers, Catal. N.Z. Crust., p. 59.
1882. *Petrolisthes*, Haswell, Catal. Austral. Crust., p. 145.
1888. *Petrolisthes*, Henderson, Rep. Anom. Chall. Exped., p. 104.

Carapace subovate, depressed, usually slightly longer than broad; front triangular, with the sides entire; lateral margins more or less undulated, not spinose. Eyes rather large. Chelipedes broad and flattened. Ambulatory legs with short robust dactyli, ending in a single claw.

Sides of carapace entire, front quite entire .. 1. *P. elongatus.*
Sides of carapace with a spine or small tooth, front with small spines .. .. 2. *P. novæ-zelandiæ.*

1. **Petrolisthes elongatus,** M.-Edw. Plate XXI, fig. 8.

1837. *Porcellana elongata*, M.-Edw., Hist. Nat. Crust., ii., p. 251.
1843. *Porcellana elongata*, White, Dieffenb. N.Z., ii., p. 265.
1874. *Petrolisthes elongatus*, Miers, Zool. "Erebus" and "Terror," Crust., p. 3, pl. iii., fig. 3.
1876. *Petrolisthes elongatus*, Miers, Catal. N.Z. Crust., p. 60.

Carapace nearly smooth, covered with fine granulations and rather convex, rotundate in form, with thin entire lateral margins, which end in a subacute tooth outside the eyes; front triangular, entire, depressed, with a median groove, apex subacute or obtuse.

Basal joint of antennules hardly visible from above.

Outer maxillipedes with all the joints smooth on the outer margins.

Chelipedes large, granular; meros with a strong obtuse tooth on its upper margin; carpos with the outer and upper margin thin and nearly entire or with a slightly defined tooth at the proximal end, lower margin with about three shallow teeth near the apex or quite entire; propodos wide, with strong curved fingers.

Ambulatory legs compressed, with the meros smooth and much dilated, especially in the two last pairs; propodos with numerous longish hairs, that of the anterior pair spinose on the lower margin; dactylos short and very hairy.

Colour: Slaty-blue above, lighter below. T. W. Kirk, describing living examples (Trans. N.Z. Inst., vol. xi., p. 396), says, "Above dark-blue, greenish-blue, or sometimes even black; below green, getting much darker towards the posterior margin of the anterior legs; anterior face of wrist a bright red; mobile finger and antennæ deep brown."

Size: Length of carapace, 17 mm.; breadth of carapace, 16 mm.; length of antennæ, 27 mm. When the chelipedes are stretched as widely as they will go naturally the apices of the carpi are distant 49 mm. from one another, while the tips of the fingers are 90 mm. This is taken from the largest specimen in my collection.

Distribution.—Australia and Tasmania.

Habitat.—This is one of the commonest of the New Zealand shore-crabs, and always occurs close to and a little below high-water mark. It lives under stones, its flattened carapace and greatly compressed claws enabling it to lie very close to the ground in such localities. It is an active animal, with powerful weapons of defence in its chelipedes, with which it can give a sharp nip.

2. **Petrolisthes novæ-zelandiæ**, Filhol. Plate XXI., fig. 9.

1885. *Petrolisthes novæ-zelandiæ,* Miss. de l'ile Campbell, p. 408, pl. xlviii., figs. 4 and 5.

1885. *Petrolisthes stewarti,* Filhol, *l.c.*, p. 410, pl. xlviii., fig. 1.

Carapace somewhat coarsely granular, with a short spine (not always well defined) on each side at the level of the anterior part of the cardiac region, and an acute spine outside the eyes; a transverse depression crosses the carapace between the eye-sockets, and is defined posteriorly by a row of hairs; the front is slightly depressed, and is elevated into two rounded lobes on the inside of the eye-sockets, with a groove between them, the whole front being more or less armed with sharp teeth.

The basal joints of the antennules are furnished with numerous short teeth on their outer edges, and are visible from above in front of the carapace.

Eye-peduncles with one or more short spines.

Outer maxillipedes with the third joint spinose on the outer margin.

Chelipedes with a nearly square meros; carpos with the upper margin rather thin, crest-like, and obscurely toothed (a prominent ridge is sometimes present on the outer side), and the lower margin has three more or less defined teeth.

Ambulatory feet with the meros scarcely dilated, and with only a few scattered hairs on the upper edge of the carpos and propodos; dactylos rather elongated.

Size: Length of carapace, 8 mm.; breadth of carapace, 7·5 mm.; breadth between tips of the carpi of the chelipedes (fully stretched), 15 mm.; length of antennæ, 16 mm.

Habitat.—Cook Strait and Stewart Island (*Filhol*); Wanganui (*S. H. Drew*); Lyttelton, dredged (*Chilton*); Blueskin Bay, trawled, and Bay of Islands, dredged in 8 fathoms; Akaroa, dredged in 6 fathoms (*Suter*); New Brighton, from roots of *Macrocystis* (*Suter*).

This is evidently not a shore-living species, though apparently common in shallow water. There is a great deal of variation in the extent to which the spines are developed on the sides of the carapace and the chelipedes. The largest specimens seem always to be the smoothest, and the smaller ones more spinous. Considering how great the range of this variation is among my specimens, I cannot recognise any sufficiently distinctive character on which Filhol can separate his *P. stewarti*.

Some of Suter's New Brighton specimens have the limbs very roughly granular.

Genus 2. PETROCHELES, Miers.

1876. *Petrocheles*, Miers, Ann. Mag. Nat. Hist., ser. 4, xvii., p. 222.

1876. *Petrocheles*, Miers, Catal. N.Z. Crust., p. 60.

Carapace subovate, depressed, slightly longer than broad; front triangular and with its sides spinose; lateral margins with a series of spines. Chelipedes elongated, slender, with a series of spines on the anterior margin of the carpos.

The distinction between the two genera—*Petrolisthes* and *Petrocheles*—is a very trivial one, and Miers only classes them as sub-genera.

Petrocheles spinosus, Miers.

1876. *Petrocheles spinosus*, Miers, Ann. Mag. Nat. Hist., ser. 4, xvii., p. 222.

1876. *Petrocheles spinosus*, Miers, Catal. N.Z. Crust., p. 61, pl. i., fig. 5.

This well-marked species occurs in many parts of the colony, but apparently has not been met with very abundantly. Two specimens occur in the Otago Museum one from Massacre Bay (*Captain Hutton*), and the other from Portland Island (*C. H. Robson*); I have received specimens from Waipapapa Point (*J. F. Ereeson*), and from Taylor's Mistake (*H. Suter*).

Genus 3. Porcellana, Lamarck.

Carapace suborbicular or subovate, the length usually greater than the breadth. Frontal region prominent and dentate, the teeth usually well developed. Eyes of moderate size, the orbits deep. Chelipodes moderately flattened, the carpos short and usually provided with a single projecting lobe near the proximal end of the internal margin; the digits frequently contorted. Ambulatory limbs with the dactyli short and robust, ending in a single claw.

Porcellana rupicola, Stimpson.

A single specimen is recorded, and figured by T. W. Kirk in Trans. N.Z. Inst., vol. xi., p. 396, as taken at Lyall Bay, Wellington.

Fam. GALATHEIDÆ.

Carapace elongate, regions well defined and usually rugose; front produced into a prominent and acute rostrum. Chelipedes and ambulatory limbs elongated and frequently slender. Antennules exposed; antennal peduncle directed forwards. External maxillipedes subpediform, with the ischium and meros narrow, and frequently spinose internally. Abdomen broad and well developed, simply bent or folded on itself, not applied to the underside of the thorax, terminating in a large swimming-fan formed of the telson and the appendages of the 6th segment; females with four pairs of simple slender ovigerous appendages on 2nd, 3rd, 4th, and 5th segments (those of the 2nd and 4th sometimes rudimentary); males with two pairs of well-developed accessory genital organs on the 1st and 2nd segments (those of the 1st pair sometimes rudimentary or absent), and three pairs of short, usually flattened, appendages on the 3rd, 4th, and 5th segments (all of them sometimes rudimentary).

Genus 1. Galathea, Fabricius.

Rostrum flattened and of moderate breadth. Carapace with pubescent transverse striæ; the gastric region usually with a few spines; abdomen unarmed.

Galathea pusilla, Henderson. Plate XXI., fig. 7.

1885. *G. pusilla,* Henderson, Ann. and Mag. Nat. Hist., ser. 5, vol. xvi., p. 407.

1888. *G. pusilla,* Henderson, Rep. Anom. Chall. Exped., pl. xii., fig 1.

Carapace with about eight transverse striæ fringed anteriorly with very short hairs; lateral border produced into about eight small spines. The gastric region bears a pair of spines on each side close to the base of the rostrum. The rostrum is broadly triangular, slightly depressed, and near its apex bears a minute spine on each side; at its base there is a prominent spine on each side immediately above the ocular peduncle. As seen from above a spine appears to project between the ocular peduncle and the rostrum; this is a prolongation of the first joint of the peduncle of the antenna.

The ischium of the external maxillipedes has its outer border prolonged distally into an acute spine; the meros is much shorter than the ischium, the inner border is armed near its middle with a curved acute spine, and a similar projection is present at the distal end of the outer border.

The chelipedes are pubescent, and the joints bear several short curved spines; the fingers are slightly shorter than the palm, and their opposed edges are irregularly toothed.

The ambulatory legs have the anterior borders of the meri and carpi armed with short spines and hairs; the dactyli are more than half as long as the propodi, and have a series of minute thorny spines on the posterior margin.

The abdominal segments are comparatively smooth.

Length of the largest female, 13·5 mm.; of chelipede, 14 mm.; of carapace, 7 mm.; of rostrum, 2·5 mm.; breadth of carapace, 5 mm.

The above description, taken mainly from Henderson's account of the type specimens, agrees in all essential points with the specimens in my possession, only the latter appear to be more pubescent and spinose on the appendages.

Habitat.—The species was originally described from a male and two females taken by the "Challenger" off Twofold Bay (near the south-east point of Australia), at a depth of 150 fathoms.

Of the specimens in my collection, four ovigerous females were obtained by Captain Gray from the Cook Strait cable; ten (all immature except one adult female) were collected by S. H. Drew, of Wanganui; and one small one I took in the dredge in Paterson Inlet in 8 fathoms.

Genus 2. MUNIDA, Leach.

Rostrum slender and spiniform, with a strong spine on either side of its base. Carapace with the surface usually

spinulose. One or more of the abdominal segments usually with a series of spinules on the anterior dorsal margin.

1. **Munida subrugosa,** White.

Miers, Cat. N.Z. Crust., p. 68.

The synonymy is given by Henderson, Rep. Anom. Chall. Exped., p. 124.

This is a widely spread species, having been recorded in the "Challenger" *Anomura* from four localities in Patagonia, from Monte Video, and from the Falkland Islands. Miers notes the British Museum specimens as from the Auckland Islands. I have taken it with the dredge in Otago Harbour and Paterson Inlet in from 6 to 10 fathoms of water, and occasionally it has come up Otago Harbour in countless swarms, creeping up to the steps of the jetties and on to the submerged stones under the piers. It always appears to keep near the bottom, and is rather slow and sluggish in its movements till pursued, when it jerks itself rapidly backwards.

I am strongly inclined to think that the forms described by Leach as *Grimothea gregaria* are, as Miers suggests, only a developmental stage in the life-history of *Munida*—a stage intended for the dispersion of the species. Filhol (Miss. de l'ile Campbell, p. 426) seeks to separate the New Zealand form from the Chilian, and describes it under the name of *Grimothea novæ-zealandiæ*. But it seems to me useless to found specific distinctions on the characters of immature forms, and we know almost nothing of the life-history of these Crustacea.

Grimothea occurs in our seas, especially in the summer months, in enormous shoals, which frequently colour large areas a bright-red. These shoals consist often of immense numbers of individuals, of which such masses are thrown up on the beaches as at times to create a stench. The animals swim backwards in a jerking manner by whipping the tail-fin under the body, while at the same time they hold the chelipedes extended straight out in front of them. They constitute a very common article of food for both fishes and sea-birds. Even in midwinter, when none have been seen swimming about, I have got them in hundreds in the stomachs of red- and blue-cod and hapuku. Though I have examined hundreds of individuals I have always found the sexual appendages in a more or less undeveloped condition. *Munida* has the exo-skeleton rather hard, and exhibiting considerable complexity of imbricating scales and of spines on its surface, but, with the exception of its softer and thinner texture, *Grimothea* has the same spines and markings. The difference in the length and development of the external

maxillipedes, on which Leach founded the latter genus, and on which Miers and Henderson lay so much stress, is after all a comparative one. In several large males of *Munida* the joints all show the flattened and foliaceous form characteristic of *Grimothea*, as well as the densely fringing setæ, while in one large female the joints are completely foliaceous. To show the relative lengths of the parts in the two forms, I append a table of measurements of a few individuals taken at random. The length is measured from the point of the rostral spine to the extremity of the caudal fin; the rostral (median) spine is measured from the base in the front region of the carapace The first three specimens of *Munida* were taken from Otago Harbour, the fourth from Paterson Inlet; those of *Grimothea* were all caught in Otago Harbour, but at different times. The measurements are in millimetres:—

—	Length.	Rostral Spine.	Right Chelipede.	Antenna.	External Maxillipede.
			Munida subrugosa.		
♂	54	9	59	35	21
♂	52	8·5	50	39	21
♀	45	7	45	24	20
♂	36·5	6	36	30	12
			Grimothea gregaria.		
♀	27	5	27	11	15
♀	23	5	24	12	12
♂	26	5	26	8	14
♂	22	4	23	10	13

I might multiply these examples by scores, but the result would remain much the same. The relative length of the body to that of the external maxillipedes is about 5 to 2 in *Munida* and 5 to less than 3 in *Grimothea*. The sexes are usually present in about equal proportions in shoals of *Grimothea*, a lot of seventeen taken at random from collections made in Dunedin and at the ocean beach north of Otago Heads gave eight males and nine females.

Out of a large number of specimens of *Grimothea* all had the pair of spines at the sides of the median line of the 2nd, 3rd, and 4th abdominal segments, said by Miers (*l.c.*) to be characteristic of *Munida*. On the other hand, several male specimens of the latter wanted the characteristic "spine on either side of the middle in the gastric region," while in some females they were but slightly developed.

Until, then, the life-history of these Crustaceans is worked out I am inclined to treat *Grimothea gregaria* as merely a stage in the development of *Munida subrugosa*.

2. **Munida gracilis**, Henderson.

Rep. Anom. Chall. Exped., p. 143, pl. xiv., fig. 4.

This species is characterized by its long upturned rostrum, which is about two-thirds the total length of the carapace, and by its very long slender chelipedes.

Two specimens were taken in the Tasman Sea west of New Zealand, near the line of the Australian cable, at a depth of 275 fathoms.

3. **Munida microphthalma**, A. M.-Edw.

Rep. Anom. Chall. Exped., p. 127, pl. iii., fig. 4.

This species has been found at three widely separated localities—viz., at five different stations in the West Indies, at depths varying from 390 to 1,030 fathoms; near Ascension Island, in the Atlantic, at a depth of 125 fathoms; and at a station north of the Kermadec Islands, at a depth of 600 fathoms.

Genus 3 Elasmonotus, A. M.-Edw.

This genus includes only deep-sea forms, which have the eyes more or less defectively developed and lacking pigment. They have a flattened rostrum and unarmed carapace.

Elasmonotus marginatus, Henderson.

Rep. Anom. Chall. Exped., p. 161, pl. xix., fig. 2.

Two ovigerous females were taken at Station 168 ("Challenger" Exped.), about sixty miles east of Cape Turnagain, from a bottom of blue mud, at a depth of 1,100 fathoms.

Genus 4. Uroptychus, Henderson (*Diptychus*, A. M.-Edw.).

A genus of deep-sea forms, mostly small, with the caudal swimming-fin reduced, and the limbs adapted to clinging among the branches of corals.

Three species were recorded from the seas to the north of New Zealand.

1. **Uroptychus spinimarginatus**, Henderson.

Rep. Anom. Chall. Exped., p. 176, pl. xxi., fig. 2.

Taken at Station 170, off the Kermadec Islands, at a depth of 520 fathoms. Also found south of the Philippines.

2. **Uroptychus politus**, Henderson.

Rep. Anom. Chall. Exped., p. 178, pl. vi., fig. 2.

Taken at Station 171, near the Kermadec Islands, at a depth of 600 fathoms.

3. **Uroptychus australis**, Henderson.

Rep. Anom. Chall. Exped., p. 179, pl. xxi., fig. 4.

Taken at both the preceding stations. Also met with off Port Jackson, and off the Island of Banda.

EXPLANATION OF PLATES XX., XXI.

PLATE XX.

Fig. 1. *Cryptodromia lateralis*, dorsal aspect; × 2.
Fig. 2. " ventral aspect; × 2.
Fig. 3. *Eupagurus novæ-zealandiæ*, front; × 2.
Fig. 4. " right chelipede of a large specimen seen from above; nat. size.
Fig. 5. " right chelipede, upper surface of hand; nat. size.
Fig. 6. *Eupagurus edwardsi*, front; × 2.
Fig. 7. " hand of right chelipede; × 2.
Fig. 8. *Eupagurus kirkii*, front; × 2.
Fig. 9. " right chelipede from above; × 2.
Fig. 10. " " upper surface of hand; × 2.
Fig. 11. *Eupagurus cookii*, front; × 3.
Fig. 12. " right chelipede seen from below; × 3.
Fig. 13. " " upper surface of hand; × 3.

PLATE XXI.

Fig. 1. *Eupagurus traversi*, front; × 3.
Fig. 2. " right chelipede from inside; × 3.
Fig. 3. " " from outside; × 3.
Fig. 4. *Stratiotes setosus*, front; × 2.
Fig. 5. " left chelipede from inside; × 2.
Fig. 6. " " carpos and propodos from above; × 2.
Fig. 7. *Galathea pusilla*; × 2.
Fig. 8. *Petrolisthes elongatus*; nat. size.
Fig. 9. *Petrolisthes novæ-zelandiæ*; nat. size.

ART. XXII.—*Synonymy of the New Zealand* Orchestidæ.

By GEORGE M. THOMSON, F.L.S.

[*Read before the Otago Institute, 15th November, 1898.*]

I HAVE been engaged for a long time past in endeavouring to clear up the confusion which exists as to the various forms of Amphipodous Crustacea belonging to the *Orchestidæ* (the shore-hoppers and their allies) found in New Zealand. Owing to the differences of structure in the males and females, and even among the males themselves at different periods of their development, and to the wide distribution of some of the species,

the same forms have been described by several different authors under a great many names. By the publication of his monograph on the *Gammarini* of the Gulf of Naples in 1893 Della Valle has done excellent service in bringing together in the systematic part of his work the scattered references to these species. I have myself erred not only in the creation of unnecessary new species, but also in wrongly referring my specimens to already existing species, although in the latter case the error was chiefly due to inadequate diagnosis in the first instance. While agreeing with most of Della Valle's work, I find that he has himself fallen into some errors in the opposite directions - errors which, perhaps, were not easily to be avoided by him. Thus two species may be morphologically so alike that it may seem desirable to the systematist—working only from laboratory specimens to unite them, while the habitat and mode of life of the two forms may be so distinct that we have reason to believe that they are good physiological species. As a case in point, this has been done by Della Valle in uniting *Orchestia tumida* to *O. gammarellus*. There are considerable morphological differences between the two forms, but it is in their habitat and mode of life that they show the most marked dissimilarity.

It is a difficult matter to select any features sufficiently distinctive upon which to found specific diagnosis; hence it becomes a matter both useless and rather misleading to base questions of geographical distribution on such species. After a superficial examination of some thousands, and the dissection and drawing of some hundreds of specimens, I have reduced the number of New Zealand species of *Orchestia* to seven, exclusive of the doubtful *O. serrulata* of Dana. The specimens I formerly referred to this species prove to belong to *O. gammarellus*, and I am doubtful now whether Dana's is a valid species. Among all my large collections, made from many parts of these Islands, I cannot find any which will answer to it. On the other hand, Dana's description will suit either *O. gammarellus* or *O. telluris*, while his figures are not sufficiently detailed to be of much value in classification.

The following are the forms which are represented in New Zealand: *Orchestia*, 7 species; *Hyale*, 4 species; *Hyalella*, 1 species; and *Ceina*, 1 species:—

Genus 1. Orchestia, Leach.

1. **Orchestia gammarellus**, Pallas.

(The full synonymy of this ubiquitous species is given by Della Valle, pp. 499–501, but the New Zealand and Australian references, which have been personally verified, are given herewith.)

1880. *Orchestia macleayana.*
1880. Haswell, Proc. Linn. Soc. N. S. Wales, vol. 4, p. 250, pl. 7, fig. 2.
1882. Haswell, Cat. Aust. Crust., p. 220.

1880. *Talorchestia diemenensis.*
1880. Haswell, *l.c.*, vol. 4, p. 248, pl. 7, fig. 6.
1882. Haswell, *l.c.*, p. 215.

1881. *Orchestia chilensis* (not M.-Edw.).
1881. G. M. Thomson, Trans. N.Z. Inst., vol. 13, p. 209.
1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.

1884. *Allorchestes recens.*
1884. G. M. Thomson, Trans. N.Z. Inst., vol. 16, p. 235, pl. 13, figs. 2–5.
1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.

1888. *Orchestia selkirkii.*
1888. Stebbing, Rep. Chall. Amph., p. 603, pl. 1 and 2.

Body narrow, rarely dilated, reaching to 20 mm. in length. Limbs with few spines. Second antennæ projecting straight forward from the head, peduncle and flagellum subequal. Coxal plates of 2nd gnathopoda and 1st pereiopoda produced on the posterior margin into an acute apophysis. In the males the 1st gnathopoda have rugose processes on the inferior side of the meros, carpos, and propodos; the 2nd gnathopoda have the basos greatly dilated, and the propodos very broadly oval, with a very oblique palm. The 5th pereiopoda in old males have the meros and carpos much dilated. Pleopoda normal.

Hab.—Usually found under wet stones, sea-weed, &c., between tide-marks, occasionally swimming in rock-pools. Does not appear to burrow in sand.

Locality.—Common round the coasts.

2. **Orchestia chiliensis**, Edwards.

1840. *Orchestia chiliensis.*
1840. M.-Edwards, Hist. Nat. Crust., vol. 3, p. 18.
1852. Dana, U.S. Exped., p. 867, pl. 58, fig. 4.
1862. Sp. Bate, Cat. Brit. Mus. Amph., p. 30, pl. 1*a*, fig. 8, and pl. 5, fig. 2.
1876. Miers, Cat. N.Z. Crust., p. 123.
1893. Della Valle, Gamm. d. G. d. Napoli, p. 498, pl. 2, fig. 8, and pl. 15, figs. 31–38.

1852. *Orchestia spinipalma.*
1852. Dana, Proc. Amer. Ac. Arts Sc., vol. 2, p. 203.
1852. Dana, *l.c.*, p. 875, pl. 59, fig. 4.
1862. Bate, *l.c.*, p. 28, pl. 4, fig. 9.

1853. *Orchestia mediterranea.*
1853. Costa, Rendic. Acc. Sc. Napoli, p. 171.
(For full synonymy see Della Valle, *l c.*, p. 498.)

1880. *Talorchestia terræ-reginæ.*
1880. Haswell, Proc. Linn. Soc. N. S. Wales, vol. 5, p. 98, pl. 5, fig. 4.
1882. Haswell, Cat. Aust. Crust., p. 217.

Body rather slender, reaching as much as 20 mm. in length, but usually about 12 mm. Limbs with few spines. Second antennæ usually more than half as long as the body, projecting nearly straight forward from the head. Coxal plates of 2nd gnathopoda and 1st pereiopoda produced on the posterior margin into an acute apophysis In the males the 1st gnathopoda are spinose, and have a small rugose process on the carpos and propodos; the 2nd gnathopoda have the basos narrow, the propodos narrow-oval, and the very oblique palm usually bears a rounded tooth near the hinge of the dactylos. The 5th pereipoda in old males often have the meros and carpos dilated. Pleopoda normal.

Hab.—Under stones, sea-weed, &c , at or below high-water mark.

Locality.—Dunedin, Moeraki, and Wellington. Probably common.

3. **Orchestia telluris,** Sp. Bate.

1862. *Orchestia telluris.*
1862. Sp. Bate, Brit. Mus. Cat., p. 20, pl. 3, fig. 6, and pl. 4, fig. 4.
1876. Miers, Cat. N.Z. Crust., p. 122.
1881. G. M. Thomson, Trans. N.Z. Inst., vol. 13, p. 209.
1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.

1893. *Orchestia gammarellus.*
1893. A. Della Valle, Gamm. d. G. d. Napoli, p. 500.

Body compressed, narrow-oval, about 12 mm. in length. Limbs all rather spinose. Second antennæ projecting straight forward from the head, only about one-fourth as long as the body. Coxal plates of 2nd gnathopoda and 1st pereiopoda produced on the posterior margin into an apophysis. In the males the 1st gnathopoda have rugose processes on the

carpos and propodos; the 2nd gnathopoda have a broadly ovate propodos, palm very oblique and with a large triangular tooth near the hinge. The 5th pereiopoda in old males have the meros dilated, and the carpos produced posteriorly into a large rounded plate. Pleopoda diminishing posteriorly; 3rd pair very small

Hab.—On sandy beaches, usually just above high-water mark.

Locality.—Waiwera (north of Auckland) and Otago Harbour. Not common.

Probably Filhol's species, *O. dentata*, should be assigned to this form, but it is impossible to identify it either by his description or figure.

4. **Orchestia aucklandiæ**, Sp. Bate.

1862. *Orchestia aucklandiæ.*
- 1862. Sp. Bate, Brit. Mus. Cat., p. 17, pl. 1*a*, fig. 3.
- 1876. Miers, Cat. N Z Crust., p. 121.
- 1881. G. M. Thomson, Trans. N.Z. Inst., vol. 13, p. 208.
- 1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.
- 1893. Della Valle, Gamm. d. G. d. Napoli, p. 505, pl. 57, fig. 65.

1885. *Orchestia ornata* (?).
- 1885. Filhol, Miss. de l'ile Campbell, p. 463, pl. 53, fig. 2.

1885. *Talorchestia armata* (?).
- 1885. Filhol, *l.c.*, p. 460, pl. 53, fig. 3.

Body robust in large specimens, and in old males with transverse ridges at each segment, giving a corrugated appearance; length as much as 28 mm. Limbs with few spines. Second antennæ projecting nearly straight from the head, about half as long as body, very strong. Coxal plate of 2nd gnathopoda and 1st pereiopoda produced on the posterior margin into an acute apophysis. In the males the 1st gnathopoda have rugose processes on the carpos and propodos, the 2nd gnathopoda are broad and dilated distally, palm nearly transverse, defined by a prominent tooth, and often produced into a flattish tooth about the middle. Pleopoda normal.

Hab.—At or below high-water mark, under stones, kelp, &c.; a powerful species, hopping vigorously.

Locality.—Kenepuru (*J. McMahon*), Sumner (*C. Chilton*), Timaru, Dunedin, Stewart Island. Probably common.

5. **Orchestia quoyana**, Edwards.

1840. *Orchestia quoyana.*
 1840. M.-Edwards, Hist. Nat. Crust., vol. 3, p. 19.
 1843. White, Dieffenb. N.Z., vol. 2, p. 268.
 1852. Dana, U.S. Exped., pl. 58, fig. 1.
 1893. Della Valle, Gamm. d. G. d. Napoli, p. 506, pl. 57, fig. 68.

1840. *Talitrus brevicornis.*
 1840. Edwards, *l.c.*, vol. 3, p. 15.
 1843. White, *l.c.*, vol. 2, p. 268.
 1852. Dana, *l.c.*, p. 854, pl. 56, fig. 6.
 1862. Bate, Brit. Mus. Cat., p. 9, pl. 1*a*, fig. 6.
 1876. Miers, Cat. N.Z. Crust., p. 119.
 1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 146.

1852. *Orchestia (Talitrus) novi-zealandiæ.*
 1852. Dana, Proc. Amer. Ac. Arts Sc., vol. 2, p. 235.
 1852. Dana, *l.c.*, p. 852, pl. 56, fig. 5.

1852. *Talorchestia quoyana.*
 1852. Dana, *l.c.*, p. 846.
 1862. Bate, *l.c.*, p. 16, pl. 2, fig. 7.
 1876. Miers, *l.c.*, p. 120.
 1886. Thomson and Chilton, *l.c.*, vol. 18, p. 146.

1862. *Orchestoidea (?) novi-zealandiæ.*
 1862. Bate, *l.c.*, p. 10, pl. 1, fig. 2.
 1878. G. M. Thomson, Trans. N.Z. Inst., vol. 11, p. 235.

1876. *Talitrus (?) novæ-zealandiæ.*
 1876. Miers, *l.c.*, p. 119.

Body stout and strong, reaching in old males to 29 mm. in length, and in females to 15 mm. Limbs rather thickly furnished with spines. Second antennæ from one-third to two-thirds as long as the body, spreading outwards from the head. Coxal plate of 2nd gnathopoda and 1st peræiopoda produced on the posterior margin into a short apophysis. In the males the 1st gnathopoda have no rugose processes; the 2nd gnathopoda greatly dilated, the inferior margin produced into a large tooth; palm oblique, with a large triangular projection near the joint. Pleopoda very much reduced.

Hab.—On sandy beaches, above high water, usually under masses of old sea-weed, below which it digs its burrows.

Locality.—This is the commonest sand-hopper in New Zealand, and probably occurs on every sandy beach.

6. **Orchestia tumida**, G. M. Thomson.

1885. *Talorchestia tumida.*
   1885. G. M Thomson, N.Z. Journ. Sc., vol. 2, p. 577.
   1886. G. M. Thomson, MS. (Stebbing), Proc. Zool. Soc. Lond., p. 5.
   1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.
   1887. Stebbing, Trans. Zool. Soc. Lond., vol. 12, p. 202, pl. 39, fig. A.
   1889. G. M. Thomson, Trans. N.Z. Inst., vol. 21, p. 260, pl. 13, figs. 4–8.
   1892. Chilton, Trans. N.Z. Inst., vol. 24, p. 259.

1885. *Talorchestia cookii.*
   1885. Filhol, Miss. de l'ile Campbell, p. 459, pl. 53, fig. 4.

1893. *Orchestia gammarellus.*
   1893. A. Della Valle, Gam. d. G. d. Napoli, p. 501.

Body more or less tumid, sometimes in old males nearly globular; reaching to 14 mm. in length. Limbs rather thickly furnished with spines. Second antennæ spreading away from one another, very short, not one-fourth as long as the body. Coxal plates of 2nd gnathopoda and first pereiopoda with the posterior margin straight. In the males the rugose processes on the 1st gnathopoda are scarcely visible; the 2nd gnathopoda have a very tumid propodos, palm very oblique, occupying two-thirds of the lower margin and with a rounded protuberance near the hinge. The 4th pereiopoda (not the 5th) in old males have the meros and carpos dilated. Pleopoda normal.

Hab.—On sandy beaches and sandhills, usually at some distance from the sea.

Locality.—At numerous points on the coast, from Waiwera to Stewart Island.

7. **Orchestia sylvicola**, Dana.

1852. *Orchestia sylvicola.*
   1852. Dana, Proc. Amer. Ac. Arts Sc., vol. 2, p. 202.
   1852. Dana, U.S. Exped., p. 873, pl. 59, figs. 2, 3.
   1862. Bate, Cat. Brit. Mus., p. 21, pl. 3, fig. 7.
   1876. Miers, Cat. N.Z. Crust., p. 122.
   1881. G. M. Thomson, Trans. N.Z. Inst., vol. 13, p. 209, pl. 7, fig. 4.
   1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 145.

1852. *Orchestia tenuis.*
1852. Dana, Proc. Amer. Ac. Arts Sc., vol. 2, p. 202.
1852. Dana, U.S. Exped., p. 872
1862. Bate, *l.c*, p. 29, pl 4, fig. 10.
1876. Miers, *l.c.*, p. 123.
1881. G. M. Thomson, *l.c.*, p. 209

1862. *Orchestia novæ-zealandiæ.*
1862. Bate, *l.c.*, p. 20, pl. 3, fig. 5.
1876. Miers, *l.c.*, p. 121.
1881. G. M. Thomson, *l.c.*, p. 208.

1880. *Talitrus sylvaticus.*
1880. Haswell, Pro. Linn. Soc. N. S. Wales, vol. 4, p. 246, pl. 7, fig. 1.
1882. Haswell, Cat. Aust. Crust., p. 214.
1886. Haswell, Proc. L. S. N.S.W., vol. 10, p. 1, pl. 10, fig. 1.

1880. *Talitrus assimilis.*
1880. Haswell, *l.c.*, vol. 5, p. 97, pl. 5, fig. 1.

1882. *Talitrus affinis.*
1882. Haswell, Cat. Aust. Crust., p. 214.
1886. Haswell, *l.c.*, vol. 10, p. 1, pl. 10, fig. 1.

Body much compressed, reaching to 25 mm. in length, usually only half as long. Spines on the limbs rather few and slender. Second antennæ about a third as long as the body, directed straight forward from the body. Coxal plates of 2nd gnathopoda and 1st pereiopoda produced into an acute apophysis on the posterior margin. Males very seldom met with, showing dimorphism, some resembling the females and a few having rugose processes on the 1st gnathopoda and a large broadly ovoid propodos in the 2nd gnathopoda. Posterior pair of pereiopoda very long. Pleopoda very much reduced in size.

Hab.—Among dead leaves, decayed wood, roots of grass, &c., in the bush, often many miles from the sea.

Locality.—In all parts of the colony.

Genus 2. Hyale, Rathke.

1. **Hyale prevostii**, Edwards.

(I only give here the synonymy as it refers to New Zealand forms of the species; for full synonymy, see Della Valle, Gam. d. G. d. Napoli, p. 519.)

1852. *Allorchestes novi-zealandiæ.*
1852. Dana, U.S. Exp., p. 894, pl. 61, fig. 1.
1862. Bate, Brit. Mus. Cat., p. 37, pl. 6, fig. 3.
1876. Miers, Cat. N.Z. Crust., p. 125.

1879. *Nicea novæ-zealandiæ.*
1879. G. M. Thomson, Trans. N.Z. Inst., vol. 11, p. 235, pl. 10, fig. B1.

1879. *Nicea fimbriata.*
1879. G. M. Thomson, *l.c.*, p. 236, pl. 10, fig. B2.

1886. *Allorchestes neo-zealanicus.*
1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 144.
1889. G. M. Thomson, *l.c.*, vol. 21, p. 260, pl. 13, fig. 3.

1886. *Nicea neo-zealanica.*
1886. Thomson and Chilton, *l.c.*, p. 144.

1888. *Allorchestes georgianus.*
1888. Pfeffer, Krebse v. Süd-Georg., 2 theil, p. 77, pl. 1, fig. 1.

1888. *Hyale prevostii.*
1888. Stebbing, Rep. Chall. Amph., p. 144.

1895. *Hyale novæ-zealandiæ.*
1895. G. M. Thomson, *l.c.*, vol. 27, p. 211.

1895. *Hyale fimbriata.*
1895. G. M. Thomson, *l.c.*, vol. 27, p. 211.

Body stout, reaching to a length of 21 mm. First antennæ reaching slightly beyond the peduncle of the 2nd pair; 2nd antennæ scarcely half as long as body. Coxal plate of 1st gnathopoda having an acute apophysis on the posterior margin; propodos oblong, palm transverse. Second gnathopoda in the female somewhat similar to the 1st pair; in the male the carpos is very short and scoop-like; the propodos is very variable in form, more or less ovoid, with the palm very oblique, usually defined by two spines, and often densely fringed with hairs. Pereiopoda with small setose spines; claws with a fine sensory (?) seta.

Hab.—In rock-pools between tide-marks, and throughout the littoral zone on all parts of the New Zealand coast and the islands lying to the south and south-east as far as Macquarie Island.

This is a widespread species in both hemispheres. I have on several occasions got it from the stomachs of coast-haunting fishes (moki, &c.).

2. **Hyale pontica**, Rathke.

(For full synonymy, see Della Valle, *l.c.*, p. 523, where, however, there is considerable confusion as to some of the forms. Our species is by him mixed up with *H. prevostii*, from which it is quite distinct.)

1879. *Nicea rubra.*
1879. G. M. Thomson, Trans. N.Z. Inst., vol. 11, p. 236, pl. 10, fig. B3.
1886. Thomson and Chilton, Trans. N.Z. Inst., vol. 18, p. 144.

Body as in *H. prevostii*, but rather more slender, and only from 10–12 mm. in length. First antennæ reaching considerably beyond the peduncle of the 2nd pair; flagellum many-jointed. Second antennæ from half to two-thirds as long as the body; flagellum very many jointed. The coxal plate of the 1st gnathopoda has the posterior margin nearly straight; the propodos is oblong and the palm slightly oblique in both sexes. The 2nd gnathopoda in the males have a large evenly ovate propodos, the palm very oblique, and occupying two-thirds of its lower margin.

Hab.—This species occurs in similar localities to the last—indeed, all the species of *Hyale* live in the littoral zone, and most commonly between tide-marks.

I have it from Dunedin and various points on the east coast of the South Island.

3. **Hyale lubbockiana**, Sp. Bate.

Della Valle has included the species described by Sars (Crust. of Norway, p. 27) as *H. lubbockiana* under *H. pontica*. In this I am convinced he is quite wrong. Sars's figures are very excellent and convincing; unfortunately, Della Valle's are misleading.

The synonymy of the species is to be found in Della Valle (*l.c.*, p. 526).

The form of the body is very similar to that of the last species. The antennæ resemble those of *H. prevostii*. The 1st gnathopoda have the posterior margin of the coxal plate almost entire, with only the trace of an apophysis. In the females the propodos is rectangular in form, and is as long as the two preceding joints; in the males the carpos is transversely greatly developed into a deeply projecting ciliated plate. The 2nd gnathopoda in the males have the basos rather dilated; the propodos is very large and subquadrate, the palm being nearly transverse. The propoda of the pereiopoda have one or two large rugose spines near the extremity; the dactyla are strong, without any sensory seta.

Hab.—One specimen, which I include with hesitation in this species, was taken in a rock-pool on the Ocean Beach, near Dunedin.

4. **Hyale chiltoni**, n. sp.

Body rather slender, 9–11 mm. long; coxal plates rather deep. The 1st antennæ are slightly longer than the peduncle

of the succeeding pair. The 2nd antennæ are about or rather more than half as long as the body; the peduncle and the flagellum are subequal. The 1st gnathopoda have the coxal plate quadrangular, with the posterior margin entire. In the male the carpos sheathes the base of the propodos; the latter is nearly chelate, the lower margin being produced into a rounded lobe, and the dactylos being more than twice as long as the palm. In the female the propodos is quadrangular, about twice as long as broad, the palm transverse and the dactylos short. The 2nd gnathopoda in the male have the carpos reduced to a narrow concave sheath; the propodos is very large and ovoid, and the palm oblique. In the female the carpos is also produced into a large fringed sheath, while the propodos resembles that of the 1st pair, except that it is larger and more square in form. The pereiopoda are nearly unarmed, all the spines being very small.

Hab.—I have taken this very distinct species in rock-pools near Dunedin, and also have it from Lyttelton (*Suter*). A number were sent me from Waipapapa by F. J. Ericson; they were taken from the stomach of a moki.

Genus 3. HYALELLA, S. J Smith.

Hyalella mihiwaha, Chilton.

1898. Ann. and Mag. Nat. Hist., ser. 7, vol. 1, p. 423, pl. 18, figs. 1–12.

Body stout, with deep side-plates; length, 5 mm. The antennæ are subequal in length. The 1st gnathopoda have a row of long setæ on the carpos. The 2nd gnathopoda in the male have a large rectangular propodos. The 3rd uropoda are very much reduced in size.

Hab.—In fresh-water streams. Probably common on the east coast of Otago at elevations of from near sea-level to 2,000 ft.

Genus 4. CEINA, Della Valle.

Ceina egregia, Chilton.

1883. *Nicea egregia.*
1883. Chilton, Trans. N.Z. Inst., vol. 15, p. 77, pl. 2, fig. 2.

1893. *Ceina egregia.*
1893. Della Valle, Gamm. d. G. d. Napoli, p. 530.

Body compressed, almost carinated, especially in the front. Length, 6–7 mm. Integument harder than in most members of the family. First antennæ about two-thirds as long as 2nd pair: latter about half as long as the body. Second gnathopoda in male chelate. Third uropoda rudimentary and destitute of a ramus.

Hab.—Lyttelton Harbour (*Chilton*) in roots of sea-weeds.

ART. XXIII.—*The* Neuroptera *of New Zealand.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 22nd February, 1899.*]

A LIST of our *Neuroptera* was published by Mr. R. McLachlan, F.R.S., in the "Annals and Magazine of Natural History" for July, 1873, and but little has been added since. This list, however, contains no descriptions, and consequently is not of much use to those New Zealand naturalists who are unable to command a good library.

At the present time the most important work for entomologists in New Zealand is to observe the habits of our insects, and ascertain their life-histories, for many species are rapidly disappearing. But observing without putting the observations on record is of no use to any one but the observer, and in order to place on record observations on the habits of an insect it is necessary to know its scientific name. If the name of the insect is unknown the observations are useless; and if a wrong name be given to the insect the observations are worse than useless, for they propagate error and entail confusion until the error is rectified. It has been with the idea of helping field-naturalists in New Zealand to name their insects correctly that I prepared the descriptive catalogues of the *Diptera*, *Hymenoptera*, and *Orthoptera*, which were published by the Colonial Museum and Geological Survey in 1881; and the year before last I presented to this Institute a Synopsis of the New Zealand *Hemiptera*.† It is with the same object in view that I now offer a catalogue of the *Neuroptera*, compiled almost entirely from Mr. McLachlan's publications. I had hoped that Mr. McLachlan himself would have drawn up this catalogue, but I have been unable to persuade him to do so. Nevertheless, he has helped me by several criticisms, and, as he has glanced over the paper, I feel confident that no New Zealand species has been omitted. Nevertheless, I alone am responsible for any errors it may contain.

The *Neuroptera* have been variously classified by different entomologists, some of whom break them up into several orders, while a few unite the *Pseudo-neuroptera* and *Odonata* with the *Orthoptera*. The classification, however, is of no

* Reprinted in the Trans. N.Z. Inst., vol. vi., Appendix, p. xc.
† See Trans. N.Z. Inst., vol. xxx., art. xxi.

importance to my present object, and I have thought it best to follow Mr. McLachlan's list already alluded to, of which, indeed, this paper may be considered an enlarged second edition.

Group PSEUDO-NEUROPTERA.

The development is direct—that is, there is no quiescent pupal stage. The larvæ somewhat resemble the adult, but are without wings, which are developed externally.

ARTIFICIAL KEY TO THE FAMILIES.

Hind wings folded longitudinally, broader than fore wings	*Perlidæ.*
Hind wings not folded.	
Hind wings as large as the fore wings	*Termitidæ.*
Hind wings smaller than the fore wings.	
Abdomen with caudal appendages	*Ephemeridæ.*
Abdomen without caudal appendages	*Psocidæ.*

Family TERMITIDÆ.

The white-ants have the head horizontal and the antennæ short. The wings are long, narrow, and straight; the anterior and posterior are equal in shape and size; they are finely net-veined. The abdomen is ovate, and composed of ten distinct segments. The larvæ resemble the adults.

ARTIFICIAL KEY TO THE GENERA.

Antennæ 16- to 20-jointed	*Calotermes.*
Antennæ 12- to 14-jointed	*Stolotermes.*

Genus CALOTERMES, Hagen (1853).

Head rather small, triangular or rounded; eyes large, ocelli small; antennæ as long as the head, 16- to 20-jointed. Prothorax as wide, or nearly as wide, as the head, transverse, truncate or arcuate in front, with the sides and apical edge forming a semicircle. Tarsi with plantula. Wings with the subcostal nervure narrow, widening out towards the tip, and connected with the costal by five or six nervules crossing the costal area.

Soldiers short and stout, with a large cylindrical head, flattened in front and rugged or truncated before the jaws.

Distribution.—Warm climates, in both hemispheres.

Calotermes brouni.

Calotermes brouni, Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 531, pl. 36, figs. 1, 1*a* (1897). *C. improbus*, Brauer, Reise der "Novara," Neuroptera, p. 45, not of Hagen.

General colour dark reddish-brown, with the wings fuscous and the nervures chocolate-brown. Length to tip of wings, 11 mm.; to end of the body, 6 mm.

Soldier with the head ochreous, more ferruginous towards the jaws; antennæ bright-yellow, with the apices of the joints pale. The rest dull-white. Length, 6 mm.

Worker with the head pale-yellow, the rest dull-white. Length, 4 mm.

Locality.—Auckland (*Broun*).

Calotermes insularis.

Termes insularis, Walker, Cat. Neuroptera Brit. Mus., part iii., p. 521 (1853); White, Zool. "Erebus" and "Terror," Insects, pl. 7, fig. 11 (1874). *Calotermes insularis*, Hagen, Cat. Termitina in Brit. Mus., p. 6 (1858); Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 521, pl. xxxv., fig. 4 (1897).

General colour bright ferruginous; wings hyaline, nervures light brownish-yellow. Length to tip of wing, 23 mm.; to end of the body, 5 mm.; expanse of wings, 38–43 mm. The wings are much longer than in the last species.

Localities.—New Zealand (British Museum) and Victoria.

The type specimens were collected in New Zealand by Dr. Sinclair, but it does not appear to have been taken again by Captain Broun. Mr. Froggart has determined one specimen from the Melbourne Museum with it on account of the very long wings. Walker, in his description of the types, says that the wings are nearly twice the length of the body; and he gives the dimensions as length of the body 3½ lines (8 mm.), expanse of the wings 19 lines (41 mm.).

Genus Stolotermes, Hagen (1858).

Head large, circular; eyes oval, small, with coarse facets; ocelli present; antennæ 12- to 14-jointed. Prothorax heart-shaped. Tarsi without plantula; the first joint as long as those following. Neuration of the wings as in *Calotermes*.

Distribution.—Tasmania and New Zealand.

Stolotermes ruficeps.

Stolotermes ruficeps, Brauer, Reise der "Novara," Neuroptera, p. 46 (1868); Hudson, Man. N.Z. Entomology, p. 107, pl. 16, figs. 1–1*c* (1892); Froggart, Pro. Linn. Soc. of N.S.W., 2nd series, vol. xxi., p. 538, pl. 36, figs. 2, 2*a*.

General colour dark reddish-brown, the under-surface much lighter; bases of the joints of the antennæ fuscous. Length to the tip of the wings, 12 mm.; to the end of the body, 7 mm.

Soldier.—Head bright-yellow, ferruginous towards the apex; jaws black; upper surface of the thorax brownish-yellow, the rest dull-white. Length, 7–11 mm.

Localities.—Auckland and Wellington.

Family PSOCIDÆ.

Small insects with oval bodies and very small prothorax, which is partially concealed by the wings. Wings unequal in size, the fore pair larger, with few or rudimentary nervures. The larvæ live on tree-trunks, palings, &c., and are much like the adult. They are very active. Both sexes are said to possess the power of spinning a web. The common book-lice belong to this family, which has been much neglected by New Zealand entomologists.

Genus MYOPSOCUS, Hagen (1866).

Tarsi 3-jointed. Discoidal cell closed. Four posterior marginal cells.

Myopsocus novæ-zealandiæ.

Myopsocus novæ-zealandiæ, Kolbe, Entomologische Nachrichten, ix., p. 145 (1883); McLachlan, Ent. Mo. Mag., ser. 2, vol. 5, p. 270 (1894). *Psocus zealandicus*, Hudson, Man. N.Z. Entomology, p. 107, pl. 16, fig. 2 (1892).

Fuscous, the vertex with a clear spot in the middle. Wings grey, thickly sprinkled with brown, the spots at the extreme margin and in the disk confluent; cells of the fore wings with an irregular semilunar spot at the exterior margins; pterostigmata reddish-brown, trigonal, the interior margin broadly concave; nervures variegated with black and white; the first discoidal cell irregular, the anterior nervure one and a half times the length of the posterior; the fork elongated. Legs brown; femora blackish, the knees reddish; tibiæ black at their apices; first joint of the tarsus pale-red, the two last joints black. Length with wings, 5–6½ mm.

Locality.—Wellington.

The types of this species were sent by me to Mr. R. McLachlan in 1873.

Family PERLIDÆ.

The stone-flies have the antennæ setaceous, with numerous joints; the mandibles are generally rudimentary, but labial palpi are present. The prothorax is large. The abdomen is long, flattened, and with parallel sides; and there are generally two caudal setæ. The wings are unequal, the posterior ones broader, triangular in shape, and longitudinally folded when at rest, in which case they extend beyond the abdomen. The legs are widely separated, and the tarsi are 3-jointed. The larvæ resemble the adult, except in being wingless. They are found in streams, under stones. The nymph (or pupa) is active, with prominent wing-pads.

Genus STENOPERLA, McLachlan (1866).

The two first joints of the maxillary palpi are short, equal, broad; the others smooth; the third and fourth are each twice the length of the second; the fifth is shorter than the fourth. Antennæ short and slender. Wings when at rest surrounding the body; the anterior much narrower than the posterior, elongated; the transverse nervules are numerous and evenly distributed; the posterior wings three times as broad as the anterior, plicated, the transverse nervules distributed pretty evenly over the whole surface.

Distribution.—New Zealand.

Stenoperla prasina.

Chloroperla prasina, Newman, Zoologist, vol. 3, p. 852 (1845). *Hermes prasinus*, Walker, Cat. Neuroptera Brit. Mus., p. 206 (1852). *Stenoperla prasina*, McLachlan, Trans. Ent. Soc., ser. 3, vol. 5, p. 354 (1866); Hudson, Man. Entomology of N.Z., p. 106, pl. 16, fig. 3.

Green, depressed; head hardly broader than the thorax. Prothorax subtransverse, the front margin nearly straight, rounded posteriorly. Caudal setæ 13-jointed. Wings pale-green. Length, 18–20 mm.; expanse of wings, 50–58 mm.

Locality.—Throughout New Zealand.

Stenoperla (?) cyrene.

Chloroperla cyrene, Newman, Zoologist, vol. 3, p. 853 (1845). *Perla (?) cyrene*, Walker, Cat. Neuroptera Brit. Mus., p. 168 (1852); McLachlan, Trans. N.Z. Inst., vol. vi., App., p. xcii.

Black. Head scarcely depressed; antennæ with 10 joints, strong, submoniliform, scarcely shorter than the body, the joints subovate. Prothorax subtransverse, acutely angled, nearly quadrate, not much broader than the head. Caudal setæ very short, incurved, 14-jointed. Tibiæ banded with yellow. Wings blackish, semi-opaque, densely reticulated. Expanse of wings, 25 mm.

Locality.—New Zealand.

This species is not a *Chloroperla* nor a true *Perla*, nor is it a *Stenoperla*. Probably it belongs to a new genus, but well-preserved specimens are wanting for description. It is easily distinguished by its yellow tibiæ.

Genus LEPTOPERLA, Newman (1839).

Exterior portion of the fore wing with six strong parallel nervures, of which the fourth is forked at the extremity and the fifth unites with the fourth before its furcation; those

longitudinal nervures are intersected by several delicate transverse nervules. Antennæ and caudal setæ elongated. Legs elongated.

Distribution.—Tasmania and New Zealand.

Leptoperla opposita.

Perla opposita, Walker, Cat. Neuroptera Brit. Mus., p. 171 (1852). *Leptoperla opposita*, McLachlan, Trans. N.Z. Inst., vol. vi., App., p. xcii. (1874).

Black, shining, partly ferruginous. Head testaceous in front, hardly broader than the thorax; antennæ very minutely pubescent. Prothorax minutely punctured, rugulose on the disk, not broader in front, with a rim on each side and along the fore border, sides straight, angles rather sharp; scutellum with a yellow spot in front. Wings very slightly grey, darker about the transverse nervules; nervures black. Length of the body, 10 mm.; expanse of the wings, 28 mm.

Localities.—Tasmania and New Zealand.

Mr. McLachlan is of opinion that our insect is specifically distinct from that of Tasmania.

Family EPHEMERIDÆ.

The may-flies are distinguished by their unequal wings, their short antennæ, and by their long caudal setæ. The eggs are deposited in water. The larvæ are shaped like the imago, but have long jaws and false gills on each side of the abdomen. The active pupa, or nymph, crawls to the surface of the water and casts off the pupa-skin, and appears to be fully developed, although it is still covered with another very delicate pellicle, and in this stage is called the subimago. It then flies with difficulty to the shore and casts the thin pellicle. The caudal setæ grow sometimes to twice their former length, and it flies away as the imago.

The anterior margin of the wing is called the "costal" nervure, and immediately below it is the "subcostal"; and below that is the "radius": none of these are branched. Next comes a nervure which branches very near the base of the wing into an upper, called the "sector," and a lower, called the "prebrachial"; further on the sector sends out a second lower branch, the "cubitus," which thus lies between the sector and the prebrachial. Starting again from the base, three longitudinal nervures branch off together, the upper of which is called the "pobrachial," the middle the "anal," and the lower the "axillary" nervure.

ARTIFICIAL KEY TO THE GENERA.

The anal nervure meets the pobrachial at the root of the fore-wing .. .. *Ephemera.*
The anal nervure remains separate from the pobrachial.
Fifth joint of the hind tarsi very small or absent .. *Atalophlebia.*
Hind tarsi distinctly 5-jointed.
Hind tarsus shorter than the tibia.
One claw blunt in each tarsus .. .. *Coloburiscus.*
Both claws sharp in each tarsus .. .. *Chirotonetes*
Hind tarsus longer than the tibia .. .. *Oniscigaster.*

Genus EPHEMERA, Linnæus (1746).

Imago.—Pronotum somewhat transverse. Legs all functional, the hind pair the shortest, its tarsi 4-jointed; fore tibiæ longer than the femur, shorter than the tarsus in the male, equal to it in the female. Wing neuration complete and plentiful. Hind wings well developed, without a longitudinal fold. Caudal setæ very long in the male, moderate in the female, the median about as long as the others.

Subimago.—Quiescent for about twenty-four to thirty-six hours, standing with erect connivent wings upon its hinder legs, the fore legs proreet, off the ground, and the setæ placed close together.

Nymph.—Fossorial, with tracheal branchiæ upon the sides of the segments. Legs short and strong, pilose, the tibiæ distally dilated and oblique, each hind tibia produced into a spine. Head with two conical projections in front.

Distribution.—North Temperate and Indian regions.

Ephemera hudsoni.

Ephemera hudsoni, McLachlan, Ent. Mo. Mag., 1894, p. 270; Hudson, Man. N.Z. Entomology, pl. 16, fig. 4.

Imago (male).—Body castaneous, the segmental divisions narrowly darker, paler beneath. Legs pale-yellowish, the anterior femora with a short blackish line internally, their tips and those of the tibiæ and tarsal joints darker. Anterior wings vitreous, iridescent, the costal margin dark reddish-brown. Posterior wings vitreous, without markings. Caudal setæ (?). Length of body (?); of anterior wings, 19½ mm.; expanse of wings, 41 mm.

Subimago (male).—Body greyish-brown, with the segmental divisions narrowly darker. Legs pale-yellowish, with the articulations blackish. Outer caudal setæ long, the middle rudimentary. Anterior wings subopaque, pale-greyish, with two oblique, transverse, smoky bands. Posterior wings with a smoky, median, oblique band. Length of the body, 20 mm.; expanse of the wings, 41 mm.

Subimago (female).—Rather larger and more robust than

the male; the middle caudal seta well developed, but shorter than the outer two.

Locality.—Wellington.

Genus ATALOPHLEBIA, Eaton (1881).

Imago.—Pronotum of the female with a longitudinal median ridge. Hind tibiæ generally longer than the femora, and longer than the tarsus. Middle caudal seta generally developed. Hind wings with costal and subcostal nervures much arched, the radius nearly straight; transverse nervules abundant in the fore wing; those in the marginal area, before the bulla, well defined.

Subimago.—Quiescent during many hours, standing upon all its feet, with the wings erect, and with the lateral caudal setæ spreading.

Nymph.—Unknown.

Distribution.—Australasia, Japan, Ceylon, South Africa, South America.

Atalophlebia dentata.

Leptophlebia dentata, Eaton, Trans. Ent. Soc. London, 1871, p. 80, pl. 4, fig. 18. *Atalophlebia dentata*, Eaton, Trans. Linn. Soc., 2nd series, Zool., vol. iii., p. 88 (1884).

Imago.—Brown, the segments narrowly bordered with black at their tips. Setæ hairy. Wings vitreous, the marginal and submarginal areas of the fore wing dark-yellow; the cross-nervules in the marginal area before the pterostigmatic space and those in the submarginal area bordered with brown, making a cloud on the bulla. Legs brownish-yellow, the femora more or less dark at the knee, the fore tibia black at the tip. Length of body, 8 mm.; of wing, ♂ 11 mm., ♀ 7–13 mm.

Subimago.—Wings light-grey, the cross-nervules faintly bordered with darker. Neuration black.

Locality.—New Zealand.

Atalophlebia costalis.

Baetis costalis, Burmeister, Handb. der. Ent. Bd. ii., Abth. ii., p. 800 (1839). *Potamanthus costalis*, Walker, Cat. Neuroptera Brit. Mus., p. 546 (1853). *Atalophlebia costalis*, Eaton, Trans. Linn. Soc., Zool., vol. iii., p. 89.

Subimago.—Black, thorax with a whitish line in front of the wings; abdomen and legs banded with red. Length, 15 mm.

Locality.—Australia. Mentioned by McLachlan as probably occurring in New Zealand also.

Atalophlebia nodularis.

Leptophlebia nodularis, Eaton, Trans. Ent. Soc London, 1871, p. 81, pl. 1, fig. 20. *Atalophlebia nodularis*, Eaton, Trans. Linn. Soc., Zool., vol. iii., p. 89, pl. x., fig. 16e.

Imago.—Reddish-black, with translucent spaces on segments 2 to 5 of the abdomen, one on each side of a dark median longitudinal line. Caudal setæ annulated. Wings vitreous, with the marginal and submarginal areas reddish-brown. Legs reddish, the fore and hind femora with a black band in the middle. Length, 9 mm.; of the wing, 10–12 mm.; of the setæ, 16 mm.

Subimago.—Wings light-grey, with dark neuration, with an ill-defined irregular dark cloud enclosing a light space.

Locality.—Christchurch.

Atalophlebia scita.

Baetis scita, Walker, Cat. Neuroptera in Brit. Mus., p. 570 (1853). *Leptophlebia scita*, Eaton, Trans. Ent. Soc. London, 1871, p. 81, pl. 4, fig. 21. *Atalophlebia scita*, Eaton, Trans. Linn. Soc., Zool., vol. iii., p. 90, pl. x., fig. 16*f*.

Imago.—Dark-brown, the segments of the abdomen broadly tipped with black, the third to the sixth with a pair of translucent yellowish spots. Setæ annulated. Wings vitreous; the fore wings with a brown spot at the base of the costa, and with less distinct ones in the marginal area at the bulla, and in the pterostigmatic space. In the marginal area there are, in the male, 7–8 cross-nervules before the bulla and 11–13 beyond it; in the female there are 9 before and 18 beyond the bulla. Length of body, ♂ 6 mm., ♀ 9 mm.; of the wings, ♂ 7–8 mm., ♀ 11 mm.

Subimago.—Wings dark-grey, with black neuration, the nervules of the fore wings edged with darker; their scarcity behind the subcostal in the middle of the front of the disk gives rise to the appearance of a pale spot, whilst the mutual approximation of three or four about the bulla, and again in the midst of the pterostigmatic space, produces frequently two dark spots.

Locality.—New Zealand.

Genus Coloburiscus, Eaton (1887).

Imago.—Legs all functional; hind tibia longer than the femur or the tarsus; tarsi 5-jointed, the fifth joint rather indistinct; first joint of the hind tarsus shorter than the second; ungues in all the tarsi dissimilar. Posterior wings well developed, oblong-oval, with the dilatation of the marginal

area acute in front and with relatively scanty neuration in the narrow axillar region. Median caudal seta rudimentary.

Distribution.—Australia and North America.

Coloburiscus humeralis.

Palingenia humeralis, Walker, Cat. Neuroptera in Brit. Mus., p. 552 (1853); and *Baetis remota*, Walker, *l.c.*, p. 564 (1853). *Coloburus humeralis*, Eaton, Trans. Ent. Soc. London, 1871, p. 132, pl. 3, fig. 1, and pl. 6, fig. 6; and Trans. Linn. Soc., Zool., vol. iii., p. 202, pl. 18, fig. 32*a*.

Imago.—Brown. Wings vitreous, tinged at the base and in the pterostigmatic region with light-brown; cross-nervules of the fore wing edged with brown between the cubitus and pobrachial nervures in the first one-third of their length, and between the costa and the sector in the first half. Fore legs dark-brown, the hind legs yellowish-brown. Length of the body, 11 mm.; of the wing, ♂ 13 mm., ♀ 14–16 mm.; of the setæ, ♂ 15–20 and 2 mm., ♀ 15 and 1 mm.

Subimago.—Wings very light-grey, with darker narrow borders to the nervules in the greater part of the disk. Length of the setæ, 14 and 1 mm.

Locality.—Canterbury and Otago.

Genus CHIROTONETES, Eaton (1881).

Imago.—Legs all functional; hind tibia shorter than the femur but longer than the tarsus; ungues similar, narrow and hooked. Costal dilatation of the hind wing obtuse, axillar region largely developed and with abundant neuration, of which a large portion is composed of numerous long branchlets of the hindermost axillar nervure. Median caudal seta rudimentary or aborted.

Distribution.—Europe, North America, and Sumatra.

Chirotonetes (?) ornatus.

Chirotonetes (?) ornatus, Eaton, Trans. Linn. Soc., 2nd series, Zoology, vol. iii., pp. 270 and 321, pl. 19, fig. 33*c* (1888).

Imago.—Thorax dark-brown in the male, yellowish-brown in the female. Abdomen reddish-brown, with a dark triangular spot behind on each side of every intermediate segment, before the apex of which is an ochreous space. Wings vitreous; the fore wings faintly yellowish in the first portions of the marginal and submarginal areas, and tinged with brownish-black in the pterostigmatic region, where the nervules are dark-bordered. Fore legs brown, the hind legs yellowish, with dark bands on the middle and tip of each femora, the tips of the tibiæ, and the joints of the tarsi. Length, 14–15 mm.; wings, 12–16 mm.; setæ, 16 and 1 mm.

Subimago.—Wings pale-grey; fore wings with a small yellowish spot at the roots of the subcostal nervure; nervules bordered with dark-brown, their borders confluent here and there into spots, producing an irregular chequered appearance. Length of setæ, ♂ 13 mm., ♀ 11 mm.

Locality.—Christchurch.

Easily distinguished from *C. humeralis* by the dark-bordered nervules forming here and there irregular blots, by the smaller extent of yellow at the base of the wings, and by the banded femora.

Genus Oniscigaster, McLachlan (1873).

Imago.—Legs all functional; hind tibiæ shorter than the femur, but longer than the tarsus; ungues dissimilar in each tarsus. Hind wings well developed, obtusely subovate, the dilatation of the marginal area obtuse in front; axillar region well developed, largely occupied by numerous long anastomosing nervules from the inner margin. Median caudal seta shorter than the outer pair. Abdomen very robust; the sixth to ninth segments winged on each side.

Distribution.—New Zealand.

Easily recognised by the terminal segments of the abdomen being produced on each side into horny wings with sharp points directed backwards.

Oniscigaster wakefieldi.

Oniscigaster wakefieldi, McLachlan, Ent. Mo. Mag., vol. 10, p. 108 (1873); Journ. Linn. Soc., vol. 12, p. 139, pl. 5, figs. 1–5; Eaton, Trans. Linn. Soc., 2nd series, Zool., vol. iii., p. 224, pl. 21, fig. 36; Sharp, in Cambridge Natural History, vol. v., Insects, p. 412, fig. 284.

Imago.—Dark-brown, rather lighter in the male. Wings vitreous, faintly tinged with light-brown; nervules dark-edged. Legs light-brown, banded with darker. Length, 16–21 mm.; wing, ♂ 16 mm., ♀ 19–21 mm.; setæ, 17 and 5 mm. Expanse of the wings, ♂ 35 mm., ♀ 40 mm.

Subimago.—Body greyish. Wings subopaque, smoky grey; nervules of the anterior portion of the fore wing broadly edged with dark-brown. Length of the setæ, 18 and 7 mm.

Locality.—Canterbury and Nelson.

In 1874 this insect was common in the neighbourhood of Christchurch. I have lived there during the last nineteen years without seeing a single specimen. Whether they have been killed off by the trout or by the sparrows I cannot say.

Group ODONATA.

The dragon-flies are well known to all, and are easily recognised. The neuration of the wing is very complicated, too much so to allow of intelligible description without a diagram, and I must refer the student to Packard's "Guide to the Study of Insects," or to a paper by Mr. W. F. Kirby in the twelfth volume of the "Transactions of the Zoological Society of London," which can be seen in any museum library. It will be sufficient here to point out that on the anterior margin, about midway between the pterostigma and the base, there is a short, thick, transverse nervule called the "nodus," which stops the subcostal nervure. The nervules between the nodus and the base of the wing are called "ante-nodals" or "ante-cubitals," while those between the nodus and the pterostigma are called "post-nodals" or "post-cubitals." All the nervures which cross the wing obliquely are called "sectors." That which starts from the nodus is the "nodal sector," the one next behind it is the "subnodal sector." Below the subcostal nervure comes the "median nervure," and then the "submedian." The first cross-nervule uniting the median with the submedian is the "arculus," which sends off two sectors. The upper one of these branches, and that branch next to the median nervure is called the "principal sector," while the posterior branch forms the "median sector." The "triangle" is an easily recognised area which lies just below the submedian nervure and a little outside the arculus.

The larva of the dragon-flies is aquatic and carnivorous, and very unlike the imago. The pupa is active, and resembles the larva, except for its rudimentary wings. Both larva and pupa are sometimes called the nymph stage. In this stage the lower lip is attached to an elongated "mentum," or mask, which is articulated to the posterior lower portion of the head; and to this mask is articulated the large and flat labium, which differs in shape in the different tribes or families. In the *Libellulina* the labium is entire, while the large lateral palpi are serrated on their inner edges. In the *Æschnina* it is notched, and has narrow palpi with very strong spines. In the *Agrionina* it is deeply cleft, and the palpi are slender, with articulated spines. The nymphs of this tribe can also be distinguished by having three elongated gills at the end of the abdomen.

ARTIFICIAL KEY TO THE NEW ZEALAND GENERA

Wings broad and rounded near their bases.
- Apices of the triangles of the fore wings directed backwards; sectors of the arculus united at their bases.
    - Sectors of the arculus petiolate .. .. *Sympetrum.*
    - Sectors of the arculus not petiolate .. .. *Somatochlora.*

Apices of the triangles of the fore wings directed outwards; sectors of the arculus separated at their bases.
Eyes contiguous .. .. *Æschna.*
Eyes separated .. .. *Uropetala.*
Wings attenuated near their bases.
The subnodal and median sectors starting close together from the principal sector, nearer the arculus than the nodus .. .. .. *Lestes.*
The subnodal sector starting from the principal sector at the nodus, the median sector a little way behind it .. .. *Xanthagrion*

Tribe LIBELLULINA.

Eyes large and contiguous, without any tubercle behind. The first ante-nodal nervule of the fore wings is not always continuous across the lower costal space; the hind wings are rounded at the anal angle in both sexes; the triangles of the fore and hind wing differ in shape; sectors of the arculus united at the base.

Genus SYMPETRUM, Newman (1855).

Frontal tubercle slightly truncate; posterior lobe of the prothorax elevated. Pterostigma generally short or moderate; sectors of the arculus petiolate; one cross-nervule in the lower basal or median space. Fore wings with 7 or 8 (rarely 9 or 10) ante-nodal and 6 or 7 post-nodal nervules, the last ante-nodal very rarely and the first two or three post-nodals never continuous across the lower costal space; triangle rather broad, free, on a level with that of the hind wing, three or four rows of post-triangular cells; nodal sector undulated beyond the middle. Hind wings with 5 ante-nodal and 6 to 8 post-nodal nervules, the first three post-nodals not continuous across the lower costal space; triangle free.

Distribution.—Cosmopolitan.

Sympetrum bipunctatum.

Libellula (Diplax) bipunctata, Brauer, Reise der "Novara," Neuroptera, p. 26 (1868).

Head with the lips reddish, the front rather golden, with a narrow black line to the base of the antennæ; vertex yellow, the occipital triangle reddish. Thorax reddish, the sides yellowish, with black spots. Basal segment of the abdomen with a black spot on each side, the second or third with a black spot in the middle. Wings hyaline, the posterior pair yellowish at the base; costa yellow at the base; pterostigma margined with black.

Male with the legs black, the coxæ reddish, femora and tibiæ yellow on the outside. Pterostigma reddish; 9 or 10 ante-nodals.

Female with the legs yellowish, the femora black on the outside and the tibiæ on the inside; tarsi black. Pterostigma yellow; 8 or 9 ante-nodals.

Length of the body, 28 mm.; of the fore wings, 23 mm.; of the hind wings, 18 mm.

Locality.—New Caledonia.

Variety *novæ-zealandiæ*, McLachlan, Ent. Mo. Mag., 1894, p. 271.

Differs from the type chiefly in the greater extension of yellow at the base of the wings and its deeper tint. In the anterior wings of the female this colour extends to the second ante-nodal, to the arculus, and to near the end of the lower basal cell; and in the posterior wings it forms a triangular basal space reaching the triangle and continued in an oblique manner to the anal margin, some distance below the end of the membranule.

Male not known.

Locality.—Auckland and Wellington.

Tribe CORDULIINA.

Resembles *Libellulina*, but the eyes have a slight horny tubercle behind, the triangles of the wings are generally wider, the sectors of the arculus are often completely separated, the last ante-nodal nervule is always continuous, there is only a small number of post-nodal nervules, the nodal sector is never undulated beyond the middle, and the males usually have the anal angle of the wings angulated.

Genus SOMATOCHLORA, Selys (1878).

Tubercles behind the eyes slight. Pterostigma rather short. Fore wings with 7 or 8 ante-nodal and 6 to 8 post-nodal nervules; hind wings with 5 (or rarely 6) ante-nodals and 8 to 10 post-nodals. Sectors of the arculus united at their bases, but not petiolate. Basal and hypotrigonal areas undivided; lower basal (or median) area with one cross-nervule in both wings. Internal triangle of the fore wings with three cells; triangle of the hind wings followed by two cells. Superior anal appendages of the male long, subcylindrical, rather thicker in the middle; the inferior pair short, subtriangular. Those of the female long, subcylindrical, slightly curved upwards, and pointed at the apex.

Distribution.—North America and other places.

ARTIFICIAL KEY TO THE SPECIES.

Triangle of the hind wing not divided.
 Fore wing with seven ante-nodal nervules .. .. *S. smithii*.
 Fore wing with eight ante-nodal nervules .. .. *S. grayi*.
Triangle of the hind wing divided.
 Fore wing with eight ante-nodal nervules .. .. *S. braueri*.

Somatochlora smithii.

Cordulia smithii, White, Zool. "Erebus" and "Terror," Insects, pl. vi., fig. 2 (no description); Hudson, Man. N.Z. Entomology, p. 104, pl. 15, fig. 2 (1892). *C. novæ-zealandiæ*, Brauer, Reise der "Novara," Neuroptera, p. 78, tab. ii., fig. 3–3*b* (1868).

Head browny-green in front, the sides yellow. Thorax metallic bronzy-green. Wings hyaline in the male, in the female with a broad spot of pale brownish-yellow behind the pterostigma; hind wings yellowish at the base; pterostigma brown in the male, reddish in the female; triangle of fore wing divided by a nervule, that of the hind wing free; 7 ante-nodals in the fore wing and 5 in the hind wing. Legs black, the fore femora almost entirely red, the intermediate red on the inside. Abdomen dull-red, posteriorly moniliform in the male, depressed-cylindrical in the female; a median longitudinal band of blackish bronzy-green interrupted at the posterior margins of the segments by a yellow transverse line. Superior anal appendages in the male black, long, acute at the apex, and bent upwards, in the middle converging and subdilated, angled exteriorly. Inferior appendages simple, half the length, triangular, yellow. Anal appendages of the female cylindrical, incurved, acute. Length, 50 mm.; of fore wing, 35 mm.; of hind wing, 34 mm.

Locality.—Throughout New Zealand and the Chatham Islands.

Common.

Somatochlora grayi.

Epitheca grayi, de Selys, Synopsis Cordulines, p. 49 (1871).

Male.—Head with the lips yellowish, the face pale-brown, the upper part of the front metallic green. Thorax brown, with metallic-green reflections. Wings slightly tinged, the extreme base ochraceous, especially in the hind wings, where the colours expand along the membranule; neuration black, including the costa; pterostigma small, reddish; triangle traversed by a nervule in the fore wing, free in the hind wing; three post-trigonal cellules followed by two rows; the anal margin excavated, but almost filled in by the membranule, which is brownish-grey, paler at the base; 8 ante-nodals in the fore wing. Legs black, the anterior femora and an external band on the intermediate yellowish. Abdomen inflated at the base, a little constricted at the third segment, then broadening and flattening to the eighth, afterwards attenuated; oreillettes prominent. It is blackish above, excepting the first and second segments, which are yellowish, and the third to the tenth have on each side a broad yellow spot occupying their basal half. Superior anal appendages

blackish, almost double the length of the tenth segment, villose, cylindrical and straight in their first three-quarters, the apex expanding and forming a sort of club curved suddenly outwards almost at a right angle to the inner edge, the outer edge simply inclined, the extremity blunt, almost truncate. Seen in profile the upper side has a small point directed in front. Inferior appendages shorter, yellowish, subtriangular, slightly curved upwards, with a blunt point. Length of the abdomen. 39 mm.; of the hind wing, 33 mm.

Female unknown.

Locality.—New Zealand.

Somatochlora braueri.

Epitheca braueri, de Selys, Synopsis Cordulines, p. 50 (1871).

Male.—Head brown, rhinarium yellow, upper side of the front greenish, base of the eyes yellowish-brown. Thorax brown, the upper portions and sides bronzy-green. Wings tinged, slightly ochraceous at the extreme base; the posterior with the anal margin excavated, membranule large, blackish, paler at the base; pterostigma small, reddish-brown; triangles divided in all the wings; 8 ante-nodal nervules in the fore wings and 6 in the hind; 7 or 8 post-nodals. Legs brown, the tarsi blackish. Abdomen slender, brown, with bronzy reflections, with a sinuated dorsal blackish bronzy band, not well defined, prolonged over all the segments, the articulations blackish; oreillettes scarcely evident. Superior anal appendages subcylindrical, dark-brown, double the length of the tenth segment, without any tooth, slightly bent inwardly and curved outwardly in the second half, where there is a slight dilatation outwardly, the apex blunt. Inferior appendage one-quarter shorter, regularly attenuated, the extremity slender, truncated, slightly elevated. Length of the abdomen, 40 mm.; of the hind wings, 36 mm.

Female differs from the male in having a broad spot of yellowish-white below the pterostigma; 7 or 8 ante-nodals in the fore wing and 5 or 6 in the hind, 6 or 7 post-nodals in the fore wing and 8 or 9 in the hind (the right and left wings often different). Legs black, the proximal halves of the femora brown below. Anal appendages as in *S. smithii*. Length, 50 mm.; of abdomen, 36 mm.; of fore wing, 37 mm.; of hind wing, 36 mm.

Locality.—Canterbury.

Tribe ÆSCHNINA.

Eyes large and contiguous. Apices of the triangles of all the wings directed outwards; the quadrangle with transverse nervules.

Genus ÆSCHNA, Fabricius.

Eyes sinuated behind. The inferior appendage generally entire, sometimes quadrifid. Anal margin of the hind wings of the male generally projecting, with the posterior margin sinuated.

Distribution.—Widely spread in both hemispheres.

Æschna brevistyla.

Æschna brevistyla, Rambur, Hist. Névroptères, p. 205 (1842).

Face yellowish, with the margin of the upper lip and an I-shaped mark on the vertex black. Thorax reddish-brown, with two very oblique yellow lines on each side. Wings hyaline, or slightly tinged with reddish, the costal nervure reddish or yellow; pterostigma reddish-brown, narrow, longer in the female. Legs black, the femora reddish at their bases. Abdomen inflated at the base, then constricted; reddish-brown, with numerous yellow spots. Superior anal appendages in the male narrow, those of the female very short. Length, 65 mm.; of the abdomen, 46 mm.; of the fore wings, 42 mm.; of the hind wings, 42 mm.

Locality.—Eastern Australia and New Zealand.

Tribe GOMPHINA.

Eyes large, separated; apices of the triangles of the wings directed outwards; the quadrangle without nervules; wings unequal, the hinder pair broader.

Genus UROPETALA, Selys (1857).

The lower lip notched in the centre; occiput without any horns; eyes elongated; bristle of the antennæ articulated. Sides of the thorax without any salient points. Pterostigma long; all the triangles of the wings divided, the basilar space not divided. Discoidal triangle of the fore wings with the superior side as long as or longer than the interior side, and divided into three cellules. Superior anal appendages of the male flattened, narrowed at the base; inferior appendages rather shorter, not sloped.

Distribution.—New Zealand.

Uropetala carovei.

Petalura carovei, White, Zool. "Erebus" and "Terror," Insects, pl. 6, fig. 1. *Uropetala carovei*, Selys, Mon. Gomphines, p. 370, pl. 19, fig. 2 (1857).

Front of the head and occiput pale-yellow, the vertex black. Thorax black, with two large yellow spots on the pronotum and two smaller ones on the mesonotum; an oblique yellow band on each side, meeting on the back between the two pairs

of wings. Abdomen dark-brown, the base of each segment with a pair of yellow spots. Legs long, the femora brownish, the tibiæ black. Wings hyaline; the pterostigma brown, surmounting 8 to 10 cellules. Discoidal triangle of the fore wing with the superior and interior sides forming a right angle; divided into three cellules by three nervules leaving the middle of each side and meeting in the middle. The internal triangle divided in the same way. Discoidal triangle of hind wing crossed by one or two nervules. Length, ♂ 86 mm., ♀ 87–92 mm.; of abdomen, ♂ 63 mm., ♀ 62–65 mm.; of fore wing, ♂ 51 mm., ♀ 59–60 mm.; of hind wing, ♂ 48 mm., ♀ 54–56 mm.

Locality.—New Zealand; especially the North Island.

A variation occurs in the division of the discoidal triangle of the fore wing, which is often simply crossed by two nervules, one from the superior the other from the interior side. The division of the internal triangle does not vary.

Tribe AGRIONINA.

Eyes small and distant; wings equal, attenuated at their bases.

Genus LESTES, Leach (1817).

Wings horizontal in repose. Nodal sector arising three to five cells behind the nodus; the subnodal not angulated or hardly undulated; the ultra-nodal sector interposed and the short sector angular under the nodus; two supplementary sectors interposed between the subnodal and the median sectors. Pterostigma three or four times as long as broad, surmounting 2 to 4 cellules. Two ante-nodals in all the wings. Quadrilateral with the internal side a third or a fourth of the interior. Anal appendages of the female cylindrical, subulate, shorter than the last segment.

Distribution.—Cosmopolitan.

Second Section.

External inferior angle of the quadrilateral much pointed. Colour blackish-bronze, mixed with blue or clear red. Inferior appendages of the male short.

Distribution.—Asia, Australasia, Occania.

Lestes colensonis.

Agrion colensonis, White, Zool. "Erebus" and "Terror," Insects, pl. 6, fig. 3. *Lestes colensonis*, Selys, Synopsis Agrionines, p. 44 (1862); Hudson, Man. Ent. of N.Z., p. 104, figs. 3, 3*a* (1892).

Pterostigma black in the male, brown in the female, subtending three or four cells, not dilated, slightly oblique at the

end. Fore wing with 11–14 post-nodal nervures. Labrum olivaceous, edged with black; upper parts of the head bronzy-black. Prothorax black, with a dorsal touch of blue on each of the three lobes; front of the thorax bronzy-black, with a blue ante-humeral band, becoming post-humeral and almost forked in its upper part; the black band which borders it is sinuated on the outside, and prolonged above, under the wings, to the middle suture of the sides; the rest of the sides olivaceous, passing into yellowish below, where the breast is marked behind, on each side, with an elongated black spot. Abdomen slender, bronzy-blue; the 3rd to the 7th segment with a bluish basal ring, passing into yellowish, which is the colour of the lower surface. Legs yellowish-brown on the outside, black on the inside in the male. Superior appendages of the male like pincers, toothed outside, and having a tubercle at the base inside, which is the commencement of a dilatation terminated towards the middle by a very sharp tooth; the end inclined downwards, and curved slightly outwards. Inferior appendages not half the length of the superior, brown, thick, approximated, slightly attenuated.

In the female the blue of the thorax is replaced by yellow, and that of the abdomen by dull-bronze. The anal appendages are separated, subcylindrical, yellowish, shorter than the last segment; the valves slightly toothed at the tips. Legs brown inside.

Locality. —Throughout New Zealand.

Very common

Genus Xanthagrion, de Selys (1876).

Head, thorax, and abdomen medium. The post-ocular rays clear, united by an occipital line. Lower sector of the triangle arising from the basal nervule of the post-costal; pterostigma lozenge-shaped, short on all the wings; post-nodal nervules 11 to 15. No spine on the vulva of the female.

Distribution.—Australia and New Zealand.

The New Zealand species differ from those of Australia in having the basal post-costal nervule placed between the first and second ante-nodals instead of below the first.

Artificial Key to the Species.

Pterostigma surmounting one cellule.
  Yellow spots behind the eyes and on the prothorax .. *X. zealandicum.*
  No yellow spots behind the eyes or on the prothorax *X. antipodum.*
Pterostigma surmounting two cellules .. .. *X. sobrinum.*

Xanthagrion zealandicum.

Telebasis zealandica, McLachlan, Ann. Mag. Nat. His., ser. 4, vol. 12, p. 35 (1873); Trans. N.Z. Inst., vol. vi., App.,

p. xciii.; Hudson, Man. Entomology of N.Z., p. 105, pl. 15, fig. 4 (1892). *Xanthagrion zealandicum,* de Selys, Synopsis Agrionines, p. 232 (1876).

The male has the abdomen bright-red, with black rings at the sutures. Head and thorax above black, with long brownish hairs; a large red spot behind each eye, the two connected by a transverse red line. Prothorax black, its borders and three discal spots red; the posterior lobe rounded and but little projecting. Thorax with two bright-red lines; the sides reddish, with two black lines. Legs bright-red, with black spines. Superior anal appendages short, subtriangular, with an obscure tubercle inside. Inferior appendages hooked, as long as the 10th segment. Pterostigma surmounting one cellule. Length, 30–32 mm.; of abdomen, 21–24 mm.; of hind wing, 16–20 mm.; expanse, 34–38 mm.

The female has the red replaced by yellow on the head and thorax; the abdomen bronzy-black above, pale-yellowish beneath. Length, 33 mm.; of abdomen, 26 mm.; of hind wing, 20 mm.; expanse, 40 mm.

There are 13–14 post-nodal nervules and three cells between the quadrilateral and the nodus.

Locality.—Throughout New Zealand.

Common.

Xanthagrion antipodum.

Xanthagrion antipodum, de Selys, Synopsis Agrionines, p. 239 (1876).

Differs from *X. zealandicum* in having no spots behind the eyes, but a yellow occipital line only, and no yellow spots on the prothorax; the first abdominal segment has no yellow spot; the femora have a black ray on the outside. There are only 11 post-nodal nervules. The pterostigma is rather shorter than the opposite cell. Length of the abdomen, 24 mm.; of the hind wing, 17 mm.

Locality.—New Zealand.

Described from a single female specimen.

Xanthagrion sobrinum.

Telebasis sobrina, McLachlan, Ann. Nat. Hist., ser. 4, vol. 12, p. 36 (1873). *Xanthagrion sobrinum,* de Selys, Synopsis Agrionines, p. 234 (1876).

Very like *X. zealandicum,* but larger; the basal spot on the first segment of the abdomen is divided; the superior anal appendages are much exserted, scarcely half the length of the inferior, subtriangular, the lower edge concave. Four cellules between the quadrilateral and the nodus in all the wings; pterostigma surmounting fully two cellules; anterior

wings with 15 post-nodal nervules. Length, 39 mm.; of abdomen, 31 mm.; of hind wing, 22 mm.; expanse, 56 mm.

Locality.—New Zealand and Chatham Islands.

In Chatham Island specimens the basal black spot on the first abdominal segment is not divided, and there are 15 to 18 post-nodal nervules.

Group PLANIPENNIA.

The *Planipennia*, or *Neuroptera vera*, are distinguished by the larva being carnivorous, and very unlike the imago; while the pupa is quiescent and the wings are developed internally. The antennæ are long, the mouth is mandibulate, the wings are naked, and the hind wings are never folded. The tarsi are 5-jointed.

ARTIFICIAL KEY TO THE FAMILIES.

Nervures of the wing not very numerous	*Scialidæ.*
Nervures of the wing very numerous.	
Antennæ setaceous or moniliform	*Hemerobiidæ.*
Antennæ short, clavate..	*Myrmeleontidæ.*

Family SCIALIDÆ.

Large insects, with the body short and thick, the prothorax large and square. Antennæ long and setaceous. Ocelli conspicuous. Wings moderate, reticulated, the hinder pair rather smaller and with the anal space small, not plicated. The larvæ are aquatic. When full fed they leave the water, and make cells in the bank, in which the inactive pupæ undergo their transformation. They are generally known as alder-flies.

Genus CHAULIODES, Latreille (1805).

Prothorax as large as the head. Three ocelli close together. Antennæ pectinated or serrated. Neuration moderate, the nervules slender. Joints of the tarsi cylindrical. Caudal appendages of the male conical and simple.

Distribution.—Asia, Africa, America, Australia.

Chauliodes diversus.

Hermes diversus, Walker, Cat. Neuroptera in Brit. Mus., p. 205 (1852). *H. dubitatus*, Walker, *l.c.*, p. 204. *Chauliodes diversus*, McLachlan, Ann. Mag. Nat. Hist., ser. 4, vol. 4, pp. 37 and 39; Hudson, Man. Ent. of N.Z., p. 102, pl. 14, figs. 1–1*b*.

Ferruginous. Head much broader than the thorax, striped, testaceous in front, contracted hindward; antennæ piceous; prothorax with a slight longitudinal furrow, its length a little exceeding its breadth; abdomen piceous; wings long and

narrow; fore wings dingy-white, with numerous pale-brown dots, which are mostly on the pale testaceous veins; marginal region of the fore wings with twelve transverse veins (*Walker*). Length of the body, 28 mm.; expanse of the wings, 76 mm.

Locality.—New Zealand.

Family MYRMELEONTIDÆ.

The ant-lions have their wings much reticulated, the apical space with regular oblong cellules. The antennæ are generally clavate, and the legs are all similar. The larva is terrestrial, living in sand, where it makes conical hollows, at the bottom of which it lives.

Genus MYRMELEON, Linne (1748).

Antennæ short, clavate or subclavate. Abdomen long and slender.

Distribution.—Widely spread in warm latitudes.

Myrmeleon acutus.

Myrmeleon acutus, Walker, Cat. Neuroptera Brit. Mus., p. 377 (1853). *M. novæ-zealandiæ*, Colenso, Trans. N.Z. Inst., vol. 17, p. 156 (1885).

Black, slender, slightly tinged with grey; head yellow towards the mouth, with a yellow spot on each side of the face and a yellow streak by the base of each antenna; palpi tawny; antennæ wanting. Abdomen much shorter than the wings; legs black, femora beneath towards the base, and hind tibiæ yellow. Wings slightly grey, long, very narrow, slightly pointed; pterostigma pale-yellow; veins black with yellow bands; subcostal areolets simple, their veins forked at intervals from one-third of the length of the wing to the pterostigma, where there is a dark-brown spot; rows of dark-brown spots along the radius and its sector, and along the cubitus and its fork; small brown spots on the forks of the marginal veins and on the gradate veinlets towards the tip of the wing and along the hind border; a larger brown spot at the tip of the fork of the cubitus and another by the last of the quadrate areolets between the first sector of the radius and the cubitus; hind wings a little shorter and narrower than the fore wings, with a few brown dots towards the tip and along the hind border. Length of the body, 30 mm.; expanse of the wings, 71 mm. (*Walker*.)

Locality.—North Island of New Zealand.

This, or another species, is also found near Nelson, and occasionally as far south as Christchurch.

Family HEMEROBIIDÆ.

The lace-winged flies have the head vertical, with long setaceous antennæ inserted between the eyes, and indistinct ocelli. The wings are large, equal, densely reticulated, and without any anal area. The larvæ are terrestrial, the pupa enclosed in a cocoon.

ARTIFICIAL KEY TO THE GENERA.

Fore wings much dilated at the base ..		..	..	*Drepanepteryx.*
Fore wings narrowed at the base.				
No recurrent nervule ..	..	..	..	*Micromus.*
A recurrent nervule ..	..	..	..	*Stenosmylus.*

Genus STENOSMYLUS, McLachlan (1867).

Prothorax elongated, subcylindrical. Wings long and narrow, rounded or acute at the apex, subfalcate with the apical margin excised in the New Zealand species. Subcostal nervules numerous, those in the disk very numerous.

Distribution.—Australia and New Zealand.

Stenosmylus incisus.

Osmylus (?) incisus, McLachlan, Journ. of Entomology, vol. 2, p. 112, pl. 6, fig. 1 (1863). *Stenosmylus incisus*, McLachlan, Ent. Mo. Mag., vol. 6, p. 195: Hudson, Man. Ent. of N.Z., p. 101, pl. 14, fig. 2; Trans. N.Z. Inst., xxvi., p. 105.

Lurid, pubescent; antennæ yellow, slightly hairy; eyes lurid; abdomen fuscous; legs yellow, femora and tibiæ with a black spot at the knees, and another in the middle; apical joints of the tarsi black. Anterior wings narrow at the base, apical margin excised, subhyaline, sometimes tinged with brownish, clouded and irrorated with greyish fuscous; three large irregular-shaped blotches on the inner margin, and a somewhat lunate one in the apex, fuscous; costa spotted with fuscous; subcostal nervure and one in the middle of the wing yellow, all the others fuscous, dotted with white. Posterior wings marked in a similar manner, but less distinctly, and the apical margins very slightly excised. Length of the body, 17 mm.; expanse of the wings, 55 mm.

Locality.—Auckland and Otago.

Stenosmylus citrinus.

Stenosmylus citrinus, McLachlan, Ann. Mag. Nat. Hist., ser. 4, vol. 12, p. 38 (1873); Trans. N.Z. Inst., vol. 6, App., p. xcvi.: Hudson, Trans. N.Z. Inst., vol. xxv., p. 105.

Citron-yellow, obscured on the face; above blackish. Thorax black on each side. Anterior and intermediate tibiæ and posterior femora dark at each end and in the middle.

Anterior wings sprinkled with black spots; discal subapical spot, and some other small ones near the apical margin, whitish, margined with black. Posterior wings paler, with subobsolete black spots on the costal margins only; no white spots. Abdomen blackish. Length of the body, 16 mm.; expanse of wings, 32 mm.

Locality.—New Zealand.

Variable in colour. A specimen from Waitara has hardly any yellow, but is pale-grey, and has more dark points in the anterior wing. The white spots not margined with black. (*R. McL.*)

Stenosmylus latiusculus.

Stenosmylus latiusculus, McLachlan, Ent. Mo. Mag., ser. 2, vol. 5, p. 241 (1894).

Head above and pronotum yellowish; ocelli large but not prominent, approximate; antennæ pale-brown, the two basal joints and the base of the third joint yellow. Meso- and meta-nota yellowish, clouded with fuscescent. Anterior legs pale-yellow, the tips of the tibiæ and tarsal joints brownish, plantula brownish; posterior legs mostly fuscescent. Abdomen (♀) fuscous above, dull-yellowish beneath; apex obtuse, provided beneath with an ovipositor (?), which appears to consist of two closely applied 2-jointed pieces, the second joint directed backward from the first; the posterior margin of the 7th ventral segment produced in its middle into a quadrate valve, from within which a cylindrical process, broad at its base, is directed between the basal joints of the above-described apparatus. Wings long-oval, subacute at the apex, with a very slight subapical excision, ground-colour pale-grey; anterior wings with the neuration blackish and whitish irregularly alternate, giving a faint irregular tesselated appearance; pterostigmatic region long but ill-defined, whitish-testaceous; posterior wings almost without markings. Length of body, 13 mm.; of anterior wing, 26 mm.; its greatest breadth, 9 mm.; expanse of wings, 54 mm.

Locality—Otira Gorge.

Variety.—The head above and the pronotum more dusky, and the black margins of the latter rather broader. Posterior legs wholly yellowish. The anterior wings rather more strongly marked. Smaller. Expanse of wings, ♀ 45 mm.

Locality.—Greymouth (?).

Genus DREPANEPTERYX, Leach (1835).

Antennæ rather shorter than the body, moniliform, the basal joint very robust; maxillary palpi long and slender, labial palpi very short; ocelli wanting. Thorax broad. Wings broad; anterior pair much dilated and rounded at the

base, very numerous dichotomous nervures united by two longitudinal series on the costal area, and three somewhat irregularly placed oblique series on the disk, exclusive of the pair common to all the family; the apical margin excised, and with a recurved apex; the base of the inner margin with a mucronated process. Posterior wings shorter, with fewer nervures, somewhat lanceolate-acute, the hinder margin waved. Abdomen compressed. Legs long and slender.

Distribution.—Europe, Asia, &c.

Drepanepteryx instabilis.

Drepanepteryx instabilis, McLachlan, Journ. of Entomology, vol. 2, p. 115, pl. 6, fig. 4 (1863).

Reddish-fuscous; antennæ pale greyish-ochreous, annulated with brown; prothorax black at the sides; legs very pale greyish-ochreous. Anterior wings deeply excised below the apex, greyish subhyaline, clouded and irrorated with greyish-brown, forming transverse streaks on the costal margin; six sectors radii, ten gradate veinlets in the inner series, fourteen in the outer, the latter deeply margined with blackish; longitudinal veins dotted with greyish-brown. Posterior wings whitish-hyaline, interruptedly margined with grey; some of the veins blackish. Length of the body, 7½ mm.; expanse of the wings, 19 mm.

Locality.—Otago.

A variety has both series of gradate veinlets in the anterior wings margined with blackish; between them, on the costa, is a large subhyaline space without markings, and a somewhat conspicuous black spot near the base.

Drepanepteryx humilis.

Drepanepteryx humilis, McLachlan, Journ. of Entomology, vol. 2, p. 116, pl. 6, fig. 5 (1863).

Ochreous, slightly pilose; antennæ pale-ochreous; eyes lurid. Pro- and meso-thorax somewhat fuscous at the sides. Legs pale-ochreous, tarsi fuscescent. Anterior wings slightly excised at the apical margin, subhyaline, clouded with greyish-ochreous, and with a few scattered black dots, most numerous along the costal margin; apical and inner margins narrowly fuscous, spotted with white; longitudinal veins with fuscous points; nine veinlets in the inner gradate series, some of which are fuscous, thirteen in the outer. Posterior wings hyaline, pterostigma ochreous. Length of the body, 6 mm.; expanse of the wings, 15 mm.

Locality.—Auckland and Otago. Found also in Queensland.

In the New Zealand examples the posterior wings have a fuscous dash at the anal angle, but they do not sufficiently

differ from the Australian to warrant their separation specifically.

Genus MICROMUS, Rambur (1866).

The base of the costal area of the fore wing narrowed and without a recurrent nervure. Subcostal area with one basal cell.

Distribution.—Tasmania and New Zealand.

Micromus tasmaniæ.

Hemerobius tasmaniæ, Walker, Trans. Ent. Soc. of London, ser. 2, vol. 5, p. 186.

Dull-red; head tawny, with a band, a stripe, and a point on each side, hindward dull-red. Thorax with some tawny marks. Legs whitish. Wings narrow, almost vitreous; the veins whitish; fore wings pubescent; veins rather few, with brown points. Length of the body, 4–5 mm.; expanse of the wings, 10–12½ mm.

Locality —Tasmania and New Zealand.

The type is from Tasmania.

Group TRICHOPTERA.

In the caddis-flies the wings are generally hairy, with longitudinal branching nervures, and but few transverse nervules; the posterior pair are generally larger than the anterior, and folded longitudinally when at rest. The antennæ are setaceous, and the mandibles obsolete. The maxillary palpi vary much, but are always 5-jointed in the female. The legs are long and slender, and the tibiæ are often furnished with spines in addition to the movable spurs which are found at the apex and sometimes near the middle of each tibia. These spurs usually differ in colour and appearance from the spines, and are important characters in classification. The formula 2 . 4 . 4. means that the fore tibia has a pair of apical spurs, while the middle and hind tibiæ have median pairs in addition to the apical pairs.

The neuration of the anterior wings is also very important in classification, and the following remarks—taken from Mr. McLachlan—may help the student. The anterior margin is called the "costa." Parallel to the costa is a nervure called the "subcosta." At the base of the wing the subcosta emits the "radius," which runs parallel to it. Near its base the radius emits the "sector," which divides into two branches, each of which again divides. The space between the two principal branches of the sector is closed by a transverse nervule, and is called the "discoidal cell." Turning now again to the base of the wing we find another longitudinal nervure below the radius. This is the "superior cubitus,"

which almost immediately divides into two branches, which again divide. At the first furcation of the upper branch there is generally a semi-transparent whitish spot without any hairs, called the "thyridium." The "inferior cubitus" is always fine, and does not branch. At the point of its termination on the inner margin of the wing there is another transparent whitish spot, called the "arculus." The apical forks of the sector and superior cubitus divide the extremity of the wing into a number of apical cells, which are numbered from before backwards.

The larvæ are aquatic, and live in cases formed of small pieces of sticks or leaves or grains of sand, &c., fastened together by a silky secretion from a spinning-gland, which opens on the second pair of maxillæ. In a few the case is formed of the secretion only. These cases are either fixed or free. The larva inhabiting them is herbivorous, and very unlike the imago. The pupa resembles the perfect insect, becoming active before it changes into the imago. These active pupæ are often called "nymphs."

Artificial Key to the New Zealand Genera.

1. Length of the fore wing more than four times its greatest width.

Hind wing elongate, acute at the apex.
  Fore wing linear — *Setodes.*
  Fore wing lanceolate — *Oxyethira.*
Hind wing triangular, blunt at the apex.
  Tibial spurs 2 . 2 . 4 — *Pseudonema.*
  Tibial spurs 2 . 2 . 2 — *Notanatolica.*

2. Length of the fore wing between three and four times its greatest breadth.

Hind wing triangular .. .. *Leptocerus.*
Hind wing oblong.
  Length of hind wing more than three times its greatest breadth .. .. *Hydrobiosis.*
  Length of hind wing between two and three times its greatest breadth.
    Antennæ strong; tibial spurs 3 . 4 . 4 .. .. *Polycentropus.*
    Antennæ slender.
      Tibial spurs 2 . 4 . 4; a transverse vein connecting the radius with the sector .. *Psilochorema.*
      Tibial spurs 2 . 2 . 4; no transverse vein connecting the radius with the sector .. *Philaniscus.*

3. Length of the fore wing less than three times its greatest breadth.

Tibial spurs 2 . 4 . 4
  Last joint of the maxillary palpi like the others.
    Upper edge of the discoidal cell straight .. *Œconesus.*
    Upper edge of the discoidal cell excised .. *Pseudœconesus.*
  Last joint of the maxillary palpi composed of many jointlets .. .. *Hydropsyche.*
Tibial spurs 2 . 2 . 2
  Tibial spurs hairy .. .. *Olinga.*
  Tibial spurs not hairy .. .. *Pycnocentria.*

Family SERICOSTOMATIDÆ.

Maxillary palpi of the male 2- or 3-jointed, ordinarily very pubescent or pilose, and always formed in quite a different manner from those of the female; varying greatly according to the genus. Larva with non-fasciculate respiratory filaments; the case free.

Genus ŒCONESUS, McLachlan (1862).

Male.—Head quadrate; antennæ about the length of the wings, basal joint short and rather thick, not so long as the head. Maxillary palpi oval-elongate, much swollen, curved up in front of the head, their apices when viewed from above appearing as two rounded tubercles between the antennæ, moderately hairy. Labial palpi with the basal joints short, the second and third of equal length, long. Anterior tibiæ with two short spurs; intermediate and posterior, each with four long unequal spurs. Anterior wings rather short and broad, very slightly hairy, the costa much arched, apical margin almost straight; the costa from the base to the pterostigma is narrowly folded inwards; discoidal cell long and narrow; the superior cubitus does not fork before the anastomosis, and from this cause there are only eight apical cells; the anastomosis is complete and very oblique from the third apical cell; the lower part is not connected with the inner margin by a transverse nervule, and the last apical cell is continued from the apex to near the base of the wing, the apical portion being very broad; near the base of the third apical cell in all four wings is a small round hyaline spot. Posterior wings broad, folded, the discoidal cell short and triangular.

Female.—The maxillary palpi are 5-jointed, the basal joint very short, the second slightly longer, the third to the fifth still longer and nearly equal. The neuration of the anterior wings is regular, and in the posterior wings there are two additional apical forks.

Distribution.—New Zealand.

Œconesus maori.

Œconesus maori, McLachlan, Trans. Ent. Soc. London, 1862, p. 3; Jour. Linn. Soc., vol. 10, pl. 2, fig. 1.

Male.—Antennæ pale-ochreous; eyes blackish, slightly reticulated with brassy; head, thorax, and abdomen reddish-brown; legs reddish-ochreous; anterior wings rusty-brown, thickly irrorated with whitish spots, which are larger towards the base; on the inner margin are three elongated whitish spots, alternating with others of the dark ground-colour.

Posterior wings subhyaline, tinged with brownish. Length of the body, 8 mm.; expanse of wings, 21 mm.

Female.—Larger, the expanse of the wings being 30 mm.

Locality.—Wellington.

This insect, at first sight, has a somewhat deceptive resemblance to *Hydropsyche fimbriata.*

Genus Pseudœconesus, McLachlan (1894).

Male.—Antennæ, palpi, and legs practically the same as in *Œconesus.* Anterior wings without any costal fold, and no defined groove; the radius is confluent with the first apical sector (in both sexes and in both pairs as in *Œconesus*); upper edge of the discoidal cell excised (straight in *Œconesus*); apical forks Nos. 1, 2, and 3 present, the others irregular; the sixth apical cell very much dilated at its base in a nearly circular manner. Posterior wings with the apical forks Nos. 1, 2, 3, and 5 present, the neuration apparently regular.

Female.—The joints of the labial palpi shorter and broader, the terminal joint almost spoon-shaped. In both pairs of wings the apical forks Nos. 1, 2, 3, and 5 are present, and the neuration appears to be normal and regular.

Distribution.—New Zealand.

Pseudœconesus mimus.

Pseudœconesus mimus, McLachlan, Ent. Mo. Mag., 1894, p. 239.

Female.—Much like the same sex in *Œ. maori,* but slightly smaller; the pale irrorations are larger and less regular; near the base of the third apical cell is a rather large, rounded, pale spot, on each side of which is a somewhat conspicuous brown spot. On the antepenultimate ventral segment is a very strong triangular tooth. The end of the abdomen in dried specimens is very similar to that of *Œ. maori.*

Locality.—Wellington.

Pseudœconesus stramineus.

Pseudœconesus stramineus, McLachlan, Ent. Mo. Mag., 1894, p. 240.

Male.—Stramineous or pale-testaceous. Anterior wings pale-greyish, stramineous, closely irrorated with small whitish spots, apical margin narrowly interruptedly fuscescent, inner margin with four or five long fuscous lines alternating with long pale spaces. Posterior wings whitish-stramineous, the apical portion yellowish, fringes concolorous. Penultimate and antepenultimate ventral segments of the abdomen each with an acute tooth; superior appendages lateral, quadrate,

furnished with long hairs. Intermediate appendages (or penis-cover?), viewed from above, consolidated into a broad elongate plate, canaliculate above, deeply notched at the apex, furnished with very long hairs. Inferior appendages 2-branched, the branches distant, stout and cylindrical, curved so as to leave a semicircular space between them. Length of body, 7 mm.; expanse of wings, 28 mm.

Locality.—Wellington.

Female.—Like the male, but the body darker, and the anterior wings yellower. A sharp, broad, triangular tooth on the antepenultimate ventral segment. Margin of the last dorsal segment nearly straight and slightly excised in its middle. Tubular piece forming two small, broad, triangular, obtuse lobes, if viewed laterally, but open above and beneath. Length of body, 10 mm.; expanse of wings, 33 mm.

Locality.—Mount Arthur, Nelson; 2,800 ft.–4,500 ft. above the sea.

Genus OLINGA, McLachlan (1894).

Instead of *Olinx* (1870), which is preoccupied.

Antennæ slightly shorter than the wings, stout, the basal joint very long and thick, fringed beneath with long and strong hairs; vertex small, with very long hairs at the sides, turned upwards; maxillary palpi apparently 2-jointed, curved over the face, short and subcylindrical; labial palpi long. Prothorax hidden, meso- and meta-thorax scarcely hairy, shining; the former long, narrowed posteriorly, with a broad concave space in the middle above; the metathorax is much narrower, also with a concave median space, in the centre of the posterior portion of which is a triangular meta-scutellum. Legs moderately long and slender, pubescent, the tibiæ with stronger and spine-like hairs, spurs 2 . 2 . 4, furnished with spine-like adpressed hairs similar to those on the tibia, the two pairs on the posterior tibiæ very long and near together; tarsi long. Anterior wings narrow at the base, the apex widely dilated, the apical margin oblique; neuration indistinct, subcosta straight, the radius parallel, the two branches of the sector ending in long forks, which are connected by a transverse nervule, the whole membrane thickly coated with scales above. Posterior wings shorter, obtusely rounded at the apex, broad, the dorsal margin with a long fringe near the base, the membrane with procumbent hairs. Abdomen short and slender; a forked lobe proceeds from the middle of the last segment above; the penultimate segment is furnished beneath with a broad and obtuse lobe, extending beyond the apex in the male.

Distribution.—New Zealand.

Olinga feredayi.

Olinx feredayi, McLachlan, Journn. Linn. Soc., vol. 10, p. 198, pl. 2, fig. 2 (1870).

Pale-ochreous, the antennæ annulated with fuscous and with a fringe of strong black hairs below the basal joint. Wings smoky, the scales greyish-yellow, neuration darker. Abdomen blackish-fuscous, the appendages yellow. Length of the body, 5 mm.; expanse of the wings, 20 mm.

Locality.—Christchurch.

Genus Pycnocentria, McLachlan (1866).

Head transversely subquadrate, with an elongated tubercle on each side. Antennæ slender, about the length of the wings; basal joint thick, hairy, longer than the head. Maxillary palpi in the male 2-jointed, the basal joint very small and concealed, the second long and thick, curved up and furnished with long and strong hairs; those of the female 5-jointed, the basal joint short, the second long and stout, third equal to the second but thinner, the fourth and fifth shorter, equal. Anterior wings with dense pubescence, dilated before the apex; in the male there is a longitudinal fold furnished with coarse hairs extending nearly the whole length, and obliterating the discoidal cell; in the female this fold is absent. Posterior wings shorter and about as broad, obtuse at the apex; in the male with a longitudinal fold. Legs moderately long and slightly hairy; spurs 2.2.4, those of the anterior and intermediate tibiæ moderately long and unequal, both pairs of the posterior tibiæ nearly equal and close together.

Distribution.—New Zealand.

Pycnocentria funerea.

Pycnocentria funerea, McLachlan, Trans. Ent. Soc. London, 1866, p. 252.

Antennæ blackish-fuscous; head and thorax dark-chestnut, clothed with blackish hairs. Wings dark-fuscous, the folds in the male conspicuously darker; a small whitish spot at the anal angles of the anterior pair. Anterior legs greyish-ochreous, the intermediate and posterior femora and tibiæ fuscous, the tarsi ochreous. Abdomen blackish-fuscous, the divisions of the segments paler; in the male the upper margin of the last segment is produced in the middle into a long flattened lobe dilated at the base, then attenuated and obtuse at the apex, from under it project the curved points of the intermediate appendages; inferior appendages consisting of two branches, the upper obtuse and shorter than the lower; ventral surface

of the antepenultimate segment of the female with a short obtuse lobe. Length of the body, 4 mm.; expanse of the wings, 13 mm.

Locality.—Auckland.

Pycnocentria evecta.

Pycnocentria evecta, McLachlan, Journ. Linn. Soc., vol. 10, p. 199, pl. 2, fig. 3 (1870).

Head with blackish and golden hairs. Prothorax with golden hairs; meso- and meta-thorax nearly hairless, blackish-fuscous. Wings greyish, the anterior with short golden hairs. Legs yellow, the tibiæ and tarsi with blackish hairs. Abdomen reddish-brown, the appendages yellow. In the male the antepenultimate ventral segment bears a broad flattened obtuse lobe, and from the last dorsal segment protrudes a small elongately triangular subobtuse yellow lobe. Length of the body, 4 mm.; expanse of the wings, 16–17 mm.

Locality.—Christchurch.

Pycnocentria aureola.

Pycnocentria aureola, McLachlan, Journ. Linn. Soc., vol. 10, p. 200, pl. 2, fig. 4 (1870).

Like *P. evecta*, but the male has no abdominal lobes. Length of the body, 4–5 mm.; expanse of the wings, 12–19 mm.

Locality.—Auckland and Christchurch.

Genus HELICOPSYCHE, Hagen (1866).

Spurs 2 . 2 . 4, long, but the exterior spur on the anterior tibia is minute, and that on the other pairs is slightly shorter than the internal; the subapical pair on the posterior tibiæ near the apical.

This genus was founded originally to include the remarkable heliciform larvæ-cases made of grains of sand, which have only lately been hatched out in North America and Europe. In New Zealand these cases are very numerous in running streams, but the larvæ have not yet been reared. Three forms—probably indicating three different species—exist, but it is doubtful if they belong to *Helicopsyche*, as no adult insect of that genus has as yet been described from New Zealand. It is more probable that they belong to *Pycnocentria*.

Family LEPTOCERIDÆ.

Maxillary palpi 5-jointed in the male as well as in the female, strongly hairy, ordinarily ascending, and with the

last joint usually long but simple, although often flexible. Wings very pubescent, and for the most part narrow. Antennæ, as a rule, very long and slender. The larva has the respiratory filaments short, and ordinarily few in number, placed in tufts on the sides of the abdomen; the case tubular and free.

Genus PSEUDONEMA, McLachlan (1862).

Tetracentron, Brauer (1865).

Antennæ much longer than the wings, joints cylindrical, the basal joint long and thick. Maxillary palpi hairy; the basal joint short; second and third long, equal; fourth scarcely as long as the third, and less robust; fifth joint as long as the third and fourth together, flexible Labial palpi with the terminal joint long and thin. Head subtriangular, the eyes prominent. Abdomen robust. Spurs of the tibiæ 2.2.4. Anterior wings rather thickly clothed with short hairs, long, narrow, slightly dilated at the apex, which is elongated; discoidal cell broad; first apical cell much longer than the others, the second short, scarcely reaching half-way to the anastomosis, the fifth narrow and very acute, barely reaching the anastomosis. Posterior wings folded.

Distribution.—New Zealand.

The small, brown, slightly curved larva-case, formed entirely from secreted material, which is so common under stones in running streams, probably belongs to this genus, but the larva has not yet been reared.

Pseudonema obsoleta.

Pseudonema obsoleta, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 1, p. 305 (1862). *Tetracentron sarothropus*, Brauer, Verh. zool.-bot. Ges., in Wien, 1865, p. 418; Reise der "Novara," Neuroptera, p. 12, tab. i., fig. 5.

Dark-grey; basal joints of the antennæ rufous, with pale-grey hairs, the other joints reddish-black, with black and white rings. Head red, palpi piceous, with dark-grey hairs. Thorax obscure-red, with ill-defined dark stripes above. Legs dull-red, anterior femora with the upper parts black, anterior tibiæ blackish, with a yellow ring in the middle and at the apex; tarsi with very short blackish hairs; middle tibiæ dull-red, ringed with black and white hairs, first joint of the tarsi dull-red, with white hairs, the others with short black hairs. Abdomen dark-grey ringed with brown, the apex red, with pale-grey hairs. Superior anal appendages conical, yellow. Anterior wings dark-grey, densely hairy, sprinkled and banded with black and white spots. Posterior wings dark-grey, vitreous, the neuration pale-brown, the fringe alternately

black and white. Length of the body 10 mm.; expanse of the wings, 36 mm.

Locality. —Auckland and Christchurch.

Pseudonema amabilis.

Tetracentron amabile, McLachlan, Journ. Linn. Soc., vol. 10., p. 20, pl. 2, fig. 5 (1870).

Brown, with grey hairs; antennæ brown, with narrow white rings. Anterior wings elongate, narrow, obliquely truncated near the apex, pale-grey, sprinkled and clouded with brown. Posterior wings broader, subhyaline, with greyish-yellow pubescence. Legs pale-grey, tarsi and anterior tibiæ brownish. Abdomen brown, the superior appendages in the male triangular, fimbriated; the inferior appendages thick, directed upwards. Length of the body, 10 mm.; expanse of the wings, 26–28 mm.

Locality.—Christchurch.

Genus NOTANATOLICA, McLachlan (1866).

Antennæ very fine, nearly thrice the length of the wing, longer in the male than in the female, maxillary palpi very hairy, the first and fourth joints moderately long, nearly equal; the second, third, and fifth equal, each about thrice the length of the fourth. Anterior wings long and narrow, slightly hairy, costal and dorsal margins nearly parallel, discoidal cell closed; upper branch of the superior cubitus forked in the male, twice forked in the female.* Posterior wings broad, subtriangular, shorter than the anterior. Legs long; spurs 2 . 2 . 2, each tibia being provided with two small and equal apical spurs. Abdomen robust, depressed in the female. Anal appendages well developed in the male, the inferior pair biarticulate; in the female the apex of the abdomen is obtuse, with two rounded superior valves.

Distribution.—Australasia and the Malay Archipelago.

Notanatolica cognata.

Leptocerus cognatus, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 1, p. 6 (1862). *Notanatolica cognata*, McLachlan, *l.c.*, vol. 5, p. 258 (1866); Journ. Linn. Soc., vol. 10, pl. 2, fig. 6.

Antennæ dark-brown, with white tips to the joints; basal joint testaceous; palpi black, clothed with long grey hairs. Head and thorax testaceous. Abdomen brown. Legs pale greyish-ochreous. Anterior wings grey, sparingly clothed with heavy pubescence. Posterior wings hyaline, with cop-

* For the neuration of *Notanatolica*, see Trans. Ent. Soc. London, ser. 3, vol. 5, pl. 19, fig. 3.

pery iridescence. Length of the body, 10 mm.; expanse of the wings, 30 mm.

Locality.—Auckland.

Notanatolica cephalotus.

Leptocerus cephalotus, Walker, Cat. Neuroptera Brit. Mus., p. 73 (1852). *Notanatolica cephalotus*, McLachlan, Journ. Linn. Soc., vol. x., p. 213.

Ferruginous, testaceous beneath. Head broader than the thorax; palpi slightly hairy; antennæ testaceous, more than four times the length of the body, with a black ring on each joint. Thorax with three brownish stripes. Legs testaceous. Wings subhyaline, the veins testaceous. Length of the body, 8 mm.; expanse of wings, 30 mm. (*Walker.*)

Locality.—Auckland.

Mr. Walker remarks that the wings of the specimen are much rubbed, and Mr. McLachlan calls it a doubtful species.

Genus Leptocerus, Leach (1815).

Antennæ very long and slender. Maxillary palpi very long and strongly hairy. Labial palpi very small. Legs long and slender, the anterior pair much shorter than the others. Spurs 2.2.2, those on the anterior tibiæ very short, the others long. Neuration of the anterior wings differing in the sexes. In the male the upper branch of the superior cubitus is once forked at the apex, while in the female it is twice forked. Apical cells Nos. 1 and 4 not reaching the anastomosis. Posterior wings usually much broader than the anterior; apical forks Nos. 1 and 5 present.

Distribution.—Northern Hemisphere, in cold and temperate regions.

Leptocerus (?) alienus.

Leptocerus (?) alienus, McLachlan, Journ. Linn. Soc., vol. 10, p. 202 (1870).

Brown, with long dark-grey hairs; antennæ white, with black rings. Anterior wings elongate, narrow, slightly dilated at the apex, rounded, dark-grey, the longitudinal nervures with brown dots. Posterior wings sooty; in the female the superior cubitus is twice forked at the end. Length of the body, 8 mm.; expanse of the wings, 23 mm.

Locality.—Christchurch.

It is uncertain to what genus this insect should be referred. So far as the general characters and the neuration of the anterior wings are concerned, it presents no apparent generic difference from the European species of *Leptocerus*, but the neuration of the posterior wings is somewhat aberrant. (*McLachlan.*)

Genus SETODES, Rambur (1842).

Antennæ and maxillary palpi varying. Legs long and slender, the anterior pair much shorter than the others; spurs of the tibiæ 0.2.2. Neuration of the wings similar in both sexes. Anterior wings very long and narrow, lanceolate, not dilated, almost always acute, clothed with dense pubescence and with long fringes. Posterior wings still narrower than the anterior, always acute, often subfalcate at the tips. Abdomen slender.

Distribution.—Europe.

Setodes unicolor.

Setodes unicolor, McLachlan, Journ. Linn. Soc., vol. 10, p. 203, pl. 2, fig. 7 (1870).

Greyish-brown; antennæ greyish-ochreous. Anterior wings greyish-yellow, with some brown dots. Posterior wings pale-grey, subhyaline, iridescent. Legs greyish-ochreous. Abdomen greyish-ochreous, the last segment in the male with a pale fringe of hairs; superior appendages small, broad; the inferior pair approximated, elongato-triangular. Length of the body, 5 mm.; expanse of wings, 20–23 mm.

Locality.—Christchurch.

Genus PHILANISCUS, Walker (1852).

Maxillary palpi with the fifth joint long and filiform. Antennæ nearly filiform, rather stout, almost as long as the wings. Fore tibiæ with two very short spurs at the apex; middle tibiæ with a pair of long spurs at the apex; hind tibiæ with two pairs of long spurs, one at three-fourths of the length, the other at the apex.

Distribution.—New Zealand and New South Wales.

The larvæ are marine, and live among seaweed, in rock-pools, between tide-marks. (See Journ. Linn. Soc., vol. 16, p. 417 (1882); and Ent. Mo. Mag., vol. 18, p. 278; vol. 19, p. 46; vol. 24, p. 154: also N.Z. Journ. of Science, vol. 1, p. 307.)

The position of this genus is doubtful.

Philaniscus plebejus.

Philaniscus plebejus, Walker, Cat. Neuroptera Brit. Mus., p. 116 (1852). *Anomalostoma alloneura*, Brauer, Reise der "Novara," Neuroptera, p. 16, pl. 1., fig. 6 (1865).

Dull-red, the sides of the thorax greyish. Antennæ thick, pale-tawny, ringed with grey, the apices dark-grey; clypeus with golden hairs; head with four narrow lines of red hairs. Legs dull-red. Anterior wings grey, subhyaline, tessellated with pale-chestnut, with a thin, yellow, woolly coating. Pos-

terior wings hyaline, the veins reddish, the dorsal margin near the base with black hairs. Inferior appendages in the male large, curved upwards, the apices bent downwards; in the female they are acute. (*Brauer.*)

Locality.—Auckland and Christchurch.

Family HYDROPSYCHIDÆ.

Maxillary palpi 5-jointed in both sexes, long, more or less deflexed, the last joint whip-shaped, and composed of numerous minute jointlets, slightly pubescent. Wings pubescent. Antennæ variable. Larvæ without any prominent hump on the first abdominal segment, external respiratory filaments present or absent, when present usually fasciculate. Cases fixed to stones. Sometimes several larvæ live in company under a common covering. The pupa not enveloped in a special cocoon.

Genus Hydropsyche, Pictet (1834).

Antennæ very slender, the basal joint short and bulbose, the others after the second elongate, each slightly thickened within. Maxillary palpi with the second joint long, the third and fourth shorter, almost triangular, the fifth as long as the others united. Anterior wings narrow and elongate, obliquely truncated at the apex; anal lobe scarcely indicated; discoidal cell closed. Posterior wings much shorter, broader, folded, obtuse, usually with a long closed median cell.

Distribution.—Cosmopolitan.

Hydropsyche fimbriata.

Hydropsyche fimbriata, McLachlan, Trans. Ent. Soc. London, 1862, p. 9.

Antennæ pale-ochreous, annulated with dark-brown; eyes varied with brown and black. Head and thorax reddish-brown. Abdomen blackish above. Legs ochreous. Anterior wings tawny-ochreous, much darker towards the apex, with numerous small pale spots; several of these are larger towards the base; on the inner margin elongate pale spots alternate with the dark ground-colour; fringe of the apical margin conspicuously yellowish-white. Posterior wings clothed with clay-coloured hairs. Inferior anal appendages in the male with very long terminal joints, which are pointed and curved upwards, approximating at the tips. Penis pale, with a callosity before the apex beneath; apex dark-red, tumid. Length of the body, 8 mm.; expanse of the wings, 22 mm.

Locality.—Auckland.

This insect has a deceptive resemblance to *Œconesus maori.*

Hydropsyche colonica.

Hydropsyche colonica, McLachlan, Journ. Linn. Soc., vol. 11, p. 131, pl. 4, fig. 16 (1873).

Blackish, head and prothorax covered with hoary hairs; antennæ brown, with pale rings. Legs yellow. Abdomen blackish, with a broad whitish line along each side. Anterior wings long and narrow, greyish-yellow, thickly reticulated with dark-grey and with several short blackish streaks on the inner margin. Posterior wings smoky, the veins darker. In the male the last abdominal segment bears in its middle a nearly vertical short lobe, which is notched. Appendages testaceous or yellowish, the last joint of the inferior pair short, subobtuse, stout. Penis cylindrical, directed upwards, the apex thickened, bifid, bearing beneath two broad claw-shaped acute hooks. Length of the body, ♂ 7 mm., ♀ 8 mm.; expanse of wings, ♂ 22 mm., ♀ 28 mm.

Locality.—Christchurch.

Genus POLYCENTROPUS, Curtis (1835).

Antennæ strong, the joints short, the first bulbose. Maxillary palpi with the first and second joints very short, stout, almost transverse; the third and fourth cylindrical; the fifth as long as the others united, stout at the base. Anterior wings elongate-oval, densely pubescent, with short fringes. Posterior wings shorter, much broader, with obtuse apices; apical fringes short, those on the anal border longer; anal lobe well developed; discoidal cell open, and the two first costulæ generally connected near their middle by a small nervule.

Distribution.—Europe, America, Ceylon.

Polycentropus puerilis.

Polycentropus puerilis, McLachlan, Journ. Linn. Soc., vol. 10, p. 204, pl. 2, fig 8 (1870).

Fuscous, clothed with blackish and golden hairs intermingled. Antennæ yellow, with narrow brown rings. Anterior wings rather broad, the apices broadly elliptical; brown, thinly sprinkled with brownish-yellow dots. Posterior wings smoky-grey; apical forks 2 and 5 present, the first two costulæ not connected by a nervule. Legs dirty testaceous. Abdomen brown. In the male there is a narrow, elongate, testaceous lobe from the apical margin of the last dorsal segment, curved downwards; intermediate appendages needle-shaped; the superior broad and spoon-shaped; the inferior elongated. Length of the body, 5 mm.; expanse of the wings, 15 mm.

Locality.—Auckland and Christchurch.

Genus Hydrobiosis, McLachlan (1870).

Antennæ slender, the basal joint shorter than the head, and stout. Maxillary palpi long and pubescent, the two basal joints short and stouter than the others, fifth not so long as the third and fourth together. Anterior wings elongate, the costal and dorsal margins nearly parallel; the apex longly elliptical, clothed with woolly pubescence and longer hairs on the veins; fringes short; neuration not very distinct. Posterior wings shorter and broader, folded, rounded at the apex; fringes long on the dorsal margin; pubescence slight; no closed discoidal cell; a transverse vein unites the upper branch of the sector with the radius; a second unites the lower branch of the sector with the superior cubitus, and a third is placed below this, much nearer the base of the wing. Spurs 2 . 4 . 4; those on the anterior tibiæ small, on the others long and straight.

Distribution.—New Zealand.

Hydrobiosis frater.

Hydrobiosis frater, McLachlan, Journ. Linn. Soc., vol. 10, p. 207, pl. 2, figs. 9*a*, 9*b* (1870).

Brown; antennæ brown with narrow yellowish rings; vertex blackish, with dark-grey hairs; ocelli large, yellowish. Anterior wings with long woolly black and grey hairs; pterostigma elongate, brown; a space on the middle of the dorsal margin pale-grey, tufts of longer black hairs along the dorsal margin of the male only. Posterior wings subhyaline, the fringes blackish. Legs dull-red; anterior and intermediate tibiæ with a narrow median pale ring. Abdomen brown, yellowish beneath; the male with three ventral teeth. Length of the body, ♂ 5 mm., ♀ 7 mm.; expanse of the wings, ♂ 18 mm., ♀ 23 mm.

Locality.—Christchurch.

Hydrobiosis umbripennis.

Hydrobiosis umbripennis, McLachlan, Journ. Linn. Soc., vol. 10, p. 208, pl. 2, figs. 9*c*, 9*d* (1870).

Brown; antennæ yellow, with indistinct brown rings; ocelli large and conspicuous, yellow. Anterior wings brown, with blackish and whitish hairs; pterostigma darker, elongate; neuration pale yellowish-testaceous, apical fringe with yellowish dots and tufts of black hairs along the cubitus near the base. Legs pale-testaceous; the anterior tibiæ and tarsi rather brownish externally, with paler rings. Abdomen brown above, yellowish beneath; the male with but

one ventral tooth, which is long, on the apical margin of the penultimate segment. Length of the body, ♂ 8 mm., ♀ 11 mm.; expanse of the wings, ♂ 32 mm., ♀ 27 mm.

Locality.—Christchurch.

Genus PSILOCHOREMA, McLachlan (1866).

Antennæ very slender, slightly longer than the wings. Head transverse, produced in front between the antennæ, rugose, the hinder portion forming a raised collar. Ocelli very distinct. Maxillary palpi slender, slightly hairy, the two basal joints short and broad, the third longer and slender, the fourth shorter than the third, the fifth longer than the third. Mesothorax ovate, with a raised tuft of hairs in the middle in the male. Legs moderately long, alike in both sexes; spurs 2.4.4. Anterior wings narrow, the margins nearly parallel, hairy clothing short and dense; the apex somewhat dilated; on the cubital veins in the male are tufts of raised hairs; discoidal cell closed, with a smaller cell below it; apical cells long and narrow; apical forks present in all five veins. Posterior wings rather shorter and broader; pubescence scanty; apical forks present in all five veins. Abdomen moderately robust.

Distribution.—New Zealand.

In this genus the wings are nearly flat when in repose.

Psilochorema mimicum.

Psilochorema mimicum, McLachlan, Trans. Ent. Soc. London, ser. 3, vol. 5, p. 274 (1866).

Antennæ fuscous, annulated with yellow, the apical portion wholly fuscous. Head and mesothorax dark-chestnut. Anterior wings smoky, with pale-golden and whitish markings; a whitish indented fascia a little below the apex; several raised tufts of blackish hairs along the dorsal margin towards the base. Posterior wings greyish-hyaline. Legs greyish-ochreous, the tips of the tarsal joints annulated with pale-yellowish. Abdomen blackish-fuscous, the appendages testaceous. In the male the superior appendages are very small, slender at the base and clavate, hairy; inferior appendages very large and broad, concave and furnished with numerous minute blackish teeth internally, the outer margin broadly emarginate. Between the inferior appendages, on the superior portion, arises a long flattened and obtuse piece, probably the upper penis-cover. Length of the body, 6½ mm.; expanse of wings, 16 mm.

Locality.—Auckland and Christchurch.

Psilochorema confusum.

Psilochorema confusum, McLachlan, Journ. Linn. Soc., vol. 10, p. 210, pl. 2, fig. 10 (1870).

Brown; antennæ yellow, indistinctly ringed with brown; basal joint with golden hairs. Anterior wings pale-brown, with pale-yellow woolly clothing mixed with black; an indistinct whitish wavy band before the apex and some pale markings on the disk. Neuration very irregular in the male. Posterior wings grey, subhyaline, iridescent, fringes grey. Legs pale-yellow; anterior and intermediate tibiæ and tarsi rather brownish externally. Abdomen brown, the apical margin of each ventral segment broadly dingy-yellowish. Inferior appendages in the male elongated and slender, bent in the middle almost at right angles. In the female the penultimate ventral segment bears a tuft of hairs in the middle. Length of the body, 4 mm.; expanse of the wings, 15 mm.

Locality.—Auckland.

Family HYDROPTILIDÆ.

Very minute, strongly pubescent and hairy, the wings with numerous erect hairs. Palpi very hairy, simple in structure, alike in both sexes. Antennæ short and stout. The larvæ are without any external respiratory filaments, and make cases usually movable (fixed in a Brazilian species), formed of silk, to the exterior of which are sometimes attached minute grains of sand. The cases have a slit at each end, and the larvæ present their heads at either indiscriminately.

Genus OXYETHIRA, Eaton (1873).

Antennæ stout, the joints somewhat cup-shaped, slightly longer than broad, the basal joint much longer than the others. Maxillary palpi slender, the third to fifth joints long. Ocelli present. Spurs 0 . 3 . 4. Anterior wings extremely long and slender, the apices narrowly acuminate, clothing very dense, costal fringes long; neuration simple, the sector ends in a long simple fork, as also does the upper branch of the superior cubitus; few, if any, transverse nervules. Posterior wings exceedingly long and narrow, the apex longly acuminate as in the anterior, very acute; the costal margin strongly elbowed near the base; sector simple, superior cubitus apparently with a small fork at the apex, a distinct median transverse nervule.

Distribution.—Europe.

Oxyethira albiceps.

Hydroptila albiceps, McLachlan, Trans. Ent. Soc. London, 1862, p. 4. *Oxyethira albiceps*, Eaton, Trans. Ent. Soc. London, 1873, p. 145 (?): Hudson, Trans. N.Z. Inst. vol. 18, p. 213; Man. N.Z. Entomology, p. 99, pl. 14, fig. 3.

Male.—Antennæ grey, faintly annulated with darker; head clothed with dense greyish-white pubescence. Thorax fuscous. Abdomen brown above, silvery beneath. Legs pale-grey. Anterior wings dark greyish-fuscous, irrorated with pale-grey, the extreme apex conspicuously whitish. Posterior wings pale-grey, the cilia concolorous. Length of the body, 2 mm.; expanse of wings, 5 mm.

Locality.—New Zealand (*Dale*); Wellington (*Hudson*).

ART. XXIV.—*The Life-history of the Tuatara* (Sphenodon punctatum).

By ARTHUR DENDY, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 22nd February, 1899.*]

THE results of my researches on the development of the Tuatara having been sent to England for publication,* it has been thought desirable to print a short account of the life-history of this remarkable animal in the "Transactions of the New Zealand Institute," in the hope that it may prove of interest to the members.

In 1896 I succeeded in making arrangements with Mr. P. Henaghan, then principal keeper on Stephens Island, in Cook Strait, for obtaining a supply of eggs, and, thanks to the untiring zeal displayed by my correspondent in the interests of science, these arrangements proved eminently successful. Mr. Henaghan also furnished me with very valuable information

* "Summary of the Principal Results obtained in a Study of the Tuatara (*Sphenodon punctatum*)."—("Proceedings of the Royal Society of London," vol. 63, 1898.)

"Outlines of the Development of the Tuatara (*Sphenodon (Hatteria) punctatum*)."—("Quarterly Journal of Microscopical Science": In the Press.)

"On the Development of the Parietal Eye and Adjacent Organs in *Sphenodon (Hatteria)*."—("Quarterly Journal of Microscopical Science": In the Press.)

concerning the breeding habits of the Tuatara, which were previously almost entirely unknown.* The eggs were sent to my laboratory packed in damp earth or sand, in tin cans, and when sent only a few at a time were found to travel very well. Indeed, later on, after the discovery of the hibernation of the embryo within the egg, my wife even took eggs to England with the living embryos in them, and they arrived safely at their destination. In the early stages of development, however, it is not very easy to prevent the eggs from either shrivelling up or going mouldy. Owing to these satisfactory arrangements it became unnecessary for me to visit Stephens Island personally, as I had thought of doing, and I was able to prepare and examine the embryos with all the conveniences afforded by my laboratory at the Canterbury College.

It appears that the failure of earlier collectors to obtain the eggs of the Tuatara was due to absence of information as to the breeding habits. It is well known that the adult animals live in holes, which are frequented also by sea-birds, and, indeed, the young of the birds serve them for food. The Tuataras, however, do not, as a rule, lay their own eggs in these holes, as was naturally enough supposed. On the other hand, Mr. Henaghan found that they make special holes for the reception of their eggs. In each of these "nests" from ten to fifteen eggs are laid, apparently by a single female, and the hole is then carefully filled in and concealed with grass or leaves.

The eggs are laid on Stephens Island during the month of November, and it is a very remarkable fact that they do not hatch until about midsummer of the year following. The earlier stages of the development are passed through much more rapidly than the later ones, and about the month of March, having already reached a very advanced stage, the development of the embryo is almost suspended for the winter months, being resumed again in the following spring. This hibernation of the embryo within the egg has been observed in only one other vertebrate animal, and that is the common European tortoise.† Certain other developmental features also indicate a close relationship between the Tuatara and the Chelonians (turtles and tortoises).

The eggs, when newly laid, are usually rather more than an inch long, and of broadly oval shape. They are almost entirely filled with yellow yolk, and contain very little albumen, or "white." As the time of hatching approaches the

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* See, however, Professor Thomas's paper, "Preliminary Note on the Development of the Tuatara (*Sphenodon punctatum*)."—("Proceedings of the Royal Society of London," vol. 48; and "New Zealand Journal of Science," vol. 1, 1891.)

† *Emis orbicularis*. *Vide* Boulenger ("Nature," 27th October, 1898).

eggs swell considerably, doubtless by absorption of moisture through the leathery egg-shell. I attribute this absorption of moisture to the hygroscopic action of a semi-gelatinous fluid which is secreted in large quantity in the cavity of the enormously developed allantois. Finally, a very high state of tension is reached, when a very small incision through the egg-shell is sufficient to cause it to split open with almost explosive violence, as I twice experimentally determined.

In the later stages of development a patch of horny epidermis on the snout of the young animal forms a sharp cutting instrument, which is doubtless used for the purpose of making the necessary incision in the egg-shell. A similar structure may be observed in the chick and in numerous other vertebrate embryos.

The embryos obtained form a very perfect series, and have been classified and described under sixteen stages, distinguished by the letters of the alphabet from C to S. For a detailed description of these stages, with the necessary illustrations, I must refer the reader to my monograph on the development. It will suffice here to give a very brief sketch of the life-history.

The earlier stages closely resemble those of the tortoise, especially as regards the development of the fœtal membrane known as the amnion. This structure, as in other vertebrates, surrounds the embryo in the form of a bag or sac as it lies on the surface of the yolk. In the Tuatara this sac is continued behind the embryo for some distance, in the form of a long narrow canal or tunnel, open posteriorly. Such a structure as this "posterior amniotic canal" was entirely unknown in any animal until a few years ago, when it was discovered by the Japanese embryologist, Professor Mitsukuri, in the embryos of a tortoise. Since the publication of the summary of my observations in June last Professor Mitsukuri has kindly sent me a copy of his work, and it is really extraordinary to see how closely his drawings of the tortoise embryo agree with mine of the Tuatara. Another feature in which the young embryos of the Tuatara agree closely with those of the tortoise is the curious manner in which the head dips down into the yolk, enveloped in a peculiar membrane known as the "pro-amnion."

In general features, however, the earlier stages of the development closely resemble those of other vertebrates with heavily yolked eggs. The formation of the alimentary canal, the four pairs of gill-slits in the neck, the central nervous system, the eyes, ears, and nostrils, the notochord, the limbs, &c., takes place in the manner already well known in other types.

At stage R, however, during which the hibernation occurs,

the embryo exhibits characters of special interest. It is now far advanced in development, though there is still a very large quantity of unused yolk in the yolk-sac. The limbs are well formed, the tail is long, and the head large and very similar to that of a tortoise, a resemblance which is to a large extent retained even in the adult. On the snout is the sharp-pointed shell-cutter; and the body is marked with longitudinal and transverse bands or stripes of alternate grey and white, a pattern which is completely lost in the adult animal, which is characteristically spotted. Thus the Tuatara conforms to what appears to be a general law of coloration amongst the higher vertebrates, for it has been observed in many different types—*e.g.*, the emu—that the young animal is striped even when the adult is not striped; and there is good ground for believing that striping was the first kind of pattern to make its appearance in the ancestors of existing vertebrates.

Perhaps the most remarkable feature of stage R, however, is the plugging-up of the nostrils by a dense growth of cellular tissue, and it is a truly remarkable fact that the only other animal in which this embryonic character has been observed is the Kiwi (*Apteryx*), in which it was described some years since by the late Professor Parker. Why should two animals so widely separated zoologically as the Tuatara and the Kiwi, and both confined to New Zealand, exhibit this extraordinary feature of development? Has the plugging-up of the nostrils in the Tuatara any relation to the hibernation of the embryo, and, if so, why does the Kiwi exhibit the same character? These questions I fear it is impossible to answer in the present state of our knowledge.

At stage S the embryo has acquired nearly all the characters of the adult: the yolk is all absorbed, and the young animal hatches. One fact only needs to be mentioned here about this stage, and that concerns the teeth. In the adult Tuatara, as is well known, there are two very large cutting-teeth in front of each jaw, upper and lower. At stage S each of these four teeth is represented by three separate conical cusps, which evidently grow together with advancing age to form the very characteristic front teeth of the adult.

As regards the details of the development of the special organs much still remains to be done, and in this work I have been very fortunate in securing the co-operation of eminent specialists in England. Professor G. B. Howes, LL.D., F.R.S., has most kindly consented to undertake the investigation of the development of the skeleton, and has already commenced the work, with the assistance of one of his students. Happily I received a further supply of eggs from Mr. Henaghan in December last, which have afforded much valuable material for further investigation. Two other English specialists have also

kindly offered to investigate the detailed development of the brain and the excretory organs, but as the arrangements are not yet complete I do not feel at liberty to publish their names.

The development of that remarkable organ, the parietal or so-called "pineal" eye, might naturally have been expected to prove of exceptional interest, and these expectations have not been disappointed. This part of the subject I have myself worked out in detail, and my results have been embodied in a separate memoir. It will be remembered that in the adult Tuatara the parietal eye, although quite invisible externally, exhibits a higher degree of perfection in structure than in perhaps any other known type. This structure was first described for *Sphenodon* by Professor Baldwin Spencer. During recent years a large amount of literature has been published by various authors on the structure and development of the parietal eye in divers types of lizards, and on the corresponding structures met with in lower vertebrate types (fishes). As a result of these researches, taken in conjunction with my own observations on the development of the parietal eye in the Tuatara, we may consider ourselves justified in concluding that the ancestors of existing vertebrates possessed, in addition to the ordinary paired eyes, a *pair* of parietal eyes placed side by side on top of the head, and originating as outgrowths of the brain, and perhaps serially homologous with the ordinary paired eyes.

In existing sharks (Selachians) Locy has shown that the two parietal optic vesicles unite together in the middle line to form the so-called "epiphysis."

In bony fishes (Teleosts and *Amia*) Hill has shown that there is also a pair of outgrowths arising in a similar way from the brain, but with more or less displacement. In these fishes, however, the right vesicle alone gives rise to the "epiphysis" of the adult, while the left one separates completely from the brain, and undergoes degeneration.

In lampreys (Cyclostomes) there is again a similar pair of outgrowths, which suffer displacement in such a manner that the right vesicle comes to overlie the left. Here the right vesicle forms a fairly well organized parietal eye, and the left one the so-called "parapineal organ," and the two together, with the nerve of the parietal eye, form what is usually known as the "epiphysis" in this group.

At a very early stage in the development of the Tuatara the left parietal eye (optic vesicle) appears as an outgrowth from the fore-brain, slightly to the left of the middle line. The right parietal optic vesicle appears slightly later, and never attains anything like the same degree of organization as the left one, although exhibiting essentially the same struc-

ture. It is displaced so as to lie behind and beneath the left parietal eye, and the latter gradually shifts into the middle line. Thus the left parietal eye appears finally as a median unpaired organ, and the right parietal eye as a median elongated vesicle behind and beneath it. This very degenerate right parietal eye has been termed the "parietal stalk," while the left parietal eye was formerly assumed to have been developed by a kind of nipping-off of the end of the stalk, which in turn was more or less closely identified with the "epiphysis" or "pineal gland."

In the Tuatara, as already stated, the left parietal eye is very highly developed. It originates as a simple hollow outgrowth of the fore-brain. This soon separates from the brain, and forms a closed sac, lying beneath the integument of the top of the head. The upper part of the wall of this sac, next to the skin, thickens, and forms a very well developed biconvex lens, composed of elongated cells. The lower part of the wall forms the retina, which early becomes divided into two primary layers. In connection with the outer layer of the retina a special optic nerve is developed, and in the inner layer pigment is deposited. The large cavity of the eye, between the lens and the retina, becomes filled with a coagulable humour.

In lizards (*Lacertilia*) the development of the parietal eye appears to follow much the same course as in the Tuatara, although perhaps its paired origin has not been so clearly recognised, owing to the greater extent to which the parts concerned have undergone degeneration.

In the Tuatara, and in lizards, and perhaps in all the higher vertebrates, the so-called "epiphysis" or "pineal gland" is a composite structure formed by various outgrowths of the brain, of which the parietal eyes, or their degenerate representatives, form only a very small part.

Since the Tuatara is recognised as being the oldest surviving type of terrestrial vertebrate, belonging to a family—the *Rhynchocephalia*—which dates back to the Palæozoic (Permian) epoch, and which is now on the verge of extinction,* we might expect that its development would exhibit primitive features, and throw light upon the ancestral history of the higher vertebrates in general. To a certain extent, no doubt, this is the case; but we may expect more light to be thrown upon this subject by the comparison of the different stages in the development of the skeleton with the fossil remains of extinct vertebrate types, and until the development of the skeleton is worked out it would be rash to make any wide generalisations.

* The Tuatara is the only surviving member of this family, and it is now confined to certain small islands off the coast of New Zealand.

In the meantime, I may repeat that as regards the parietal eye the early stages of development agree exactly with those of bony fishes, while, as regards the fœtal membranes, there is an equally striking agreement with the Chelonians (turtles and tortoises), to which group some of our most eminent zoologists—*e.g.*, Boulenger—have long supposed the Tuatara to be closely related. The views of these authorities have received startling confirmation from the study of the development of the Tuatara.

Considering the evidently close relationship of the Tuatara with the turtles and tortoises, it seems almost certain that some trace of the parietal eye, which is so strongly developed in the former, will also be discovered in embryos of the latter group; and this is a point to which I would venture to direct the special attention of embryologists.

ART. XXV.—*List of New Zealand* Mollusca *described in Foreign Publications since 1890.*

By HENRY SUTER.

[*Read before the Philosophical Institute of Canterbury, 22nd February, 1899.*]

I. NON-MARINE MOLLUSCA.

Lagochilus hedleyi, Suter.
Proc. Lin. Soc. N. S. Wales (2), vol. viii., p. 484, pl. xxii., fig. 1 (1894).

Lagochilus torquillum, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 485, pl. xxii., fig. 2 (1894).

Lagochilus chiltoni, Suter.
Proc. Mal. Soc. London, vol. ii., p. 33, pl. iv., fig. 1 (1896).

Lagochilus studeri, Suter.
Proc. Mal. Soc. London, vol. ii., p. 33, pl. iv., fig. 2 (1896).

Gundlachia, sp., Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 486 (1894).

Neojanella dubia, Cockerell.
P. Z. S., 1891, p. 217.

Athoracophorus simrothi, Suter.
Proc. Mal. Soc. London, vol. ii., p. 34, pl. iv., figs. 3, 4 (1896).

Athoracophorus dendyi, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 253–255, with figs. in text (1897).

Athoracophorus schauinslandi, Plate.
Sitz. Ber. Akad. Berlin, 1897, p. 141: Zoolog. Jahrb., vol. xi., pp. 194–280, pl. ix.–xiv. (1898), Anatomy.

Janella bitentaculata, Q. and G.
Collinge: P. Z. S., 1894, pp. 528–530, Anatomy.

Janella maculata, Collinge.
P. Z. S., 1894, pp. 527–530, Diagn. and Anatomy.

Revision of the *Athoracophoridæ*, by H. Suter.
Proc. Mal. Soc. London, vol. ii., pp. 245–257 (1897).

Endodonta (Charopa) pseudocoma, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 495, pl. xxiii., fig. 9 (1894).

Endodonta (Charopa) segregata, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 496, pl. xxiii., fig. 10 (1894).

Endodonta (Charopa) anguiculus, Reeve, var. *montivaga*, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 498, pl. xxiii., fig. 11 (1894).

Endodonta (Charopa) prestoni, Sykes.
Proc. Mal. Soc. London, vol. i., p. 218, with fig. in text (1895).

Endodonta (Charopa) roseveari, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 34, 35, pl. iv., figs. 5–7 (1896).

Endodonta (Charopa) titirangiensis, Suter.
Proc. Mal. Soc. London, vol. ii., p. 35, pl. iv., figs. 8–10, (1896).

Endodonta (Charopa) vortex, Murdoch.
Proc. Mal. Soc. London, vol. ii., p. 160, with figs. in text (1897).

Endodonta (Charopa) coma, Gray, var. *multicostata*, Murdoch.
Proc. Mal. Soc. London, vol. ii., p. 161, with figs. in text (1897).

Endodonta (Ptychodon) magdalenæ, Ancey.
British Naturalist, Ap., 1891, p. 65 (is *E. hectori*, Suter, 1890).

Endodonta (Ptychodon) hunuaensis, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 494, pl. xxiii., fig. 8 (1894).

Flammulina (Phenacohelix) perplexa, Murdoch.
Proc. Mal. Soc. London, vol. ii., p. 161, with figs. in text (1897).

Flammulina (Phenacohelix) ponsonbyi, Suter.
Proc. Mal. Soc. London, vol. ii., p. 285, with figs. in text (1897).

Flammulina (Phenacohelix) pilula, Reeve (1852).
Suter: Proc. Mal. Soc. London, vol. ii., p. 284, with figs. in text (1897).

Flammulina (Therasia) traversi, E. A. Smith (1884).
Suter: P. L. S., N. S. Wales (2), vol viii., p. 490, pl. xxii., fig. 5 (1894), Dentition.

Flammulina (Allodiscus) wairoaensis, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 488, pl. xxii., fig. 3 (1894).

Flammulina (Allodiscus) urquharti, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 489, pl. xxii., fig. 4 (1894).

Flammulina (Allodiscus) chion, Sykes.
Proc. Mal. Soc. London, vol. ii., p. 107, with figs. in text (1896).

Flammulina (Allodiscus) mossi, Murdoch.
Proc. Mal. Soc. London, vol. ii., p. 162, with figs. in text (1897).

Laoma (s. str.) pirongiaensis, Suter.
P. L. S., N. S. Wales (2), vol. viii., p. 491, pl. xxii., fig. 6 (1894).

Laoma (s. str.) elegans, Suter.
Proc. Mal. Soc. London, vol. ii., p. 35, pl. iv., figs. 11, 12 (1896).

Laoma (Phrixgnathus) lucida, Suter.
Proc. Mal. Soc. London, vol. ii., p. 36, pl. iv., figs. 13–15 (1896).

Laoma (Phrixgnathus) spiralis, Suter.
Proc. Mal. Soc. London, vol. ii., p. 36, pl. iv., figs. 16–18 (1896).

Laoma (Phrixgnathus) moellendorffi, Suter.
Proc. Mal. Soc. London, vol. ii., p. 37, pl. iv., figs. 19–21 (1896).

Laoma (Phrixgnathus) hamiltoni, Suter.
Proc. Mal. Soc. London, vol. ii., p. 37, pl. iv., figs. 22–24 (1896); Macquarie Island.

Laoma (Phrixgnathus) sublucida, Suter.
Proc. Mal. Soc. London, vol. ii., p. 37 (1896).

Laoma (Phrixgnathus) phrynia, Hutton, var. *major*, Suter.
Proc. Mal. Soc. London, vol. ii., p. 259 (1897); Stewart Island.

Rhytida greenwoodi, Gray (1850).
Moss: Trans. Manchester Microsc. Soc., 1894 (p. 4, reprint), pl. ii., fig. 3, Radula.

Paryphanta hochstetteri, Pfr. (1862).
Godwin-Austen: Proc. Mal. Soc London, vol. i., pp. 5 9, pl. i. (1893), Anatomy.

Schizoglossa novo-seelandica, Pfr. (1862).
Hedley: P. L. S., N. S. Wales (2), vol. vii., pp. 387 392, pl. ix., x. (1893), Anatomy. Murdoch: Proc. Mal. Soc. London, vol. i., p. 138 (1894), Variation and Habits.

Land Mollusca of Stewart Island, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 258, 259 (1897).

II. Marine Mollusca.

Ischnochiton parkeri, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 186, 187, with figs. in text (1897).

Plaxiphora superba (Cpr.), Pilsbry.
Man. Conch. (1), vol. xiv., p. 319, pl. lxviii., figs. 55–61 (1893).

Plaxiphora suteri, Pilsbry.
Nautilus, vol. viii., p. 8 (1894).

Plaxiphora subatrata, Pilsbry.
Man. Conch. (1), vol. xiv., p. 201 (1893). Suter: Proc. Mal. Soc. London, vol. ii., pp. 190, 191, with figs. in text (1897).

Plaxiphora obtecta (Cpr.), Pilsbry.
Man. Conch. (1), vol. xiv., p. 330 (1893).

Spongiochiton productus (Cpr.), Pilsbry.
Man. Conch. (1), vol. xiv., p. 26 (1892).

Eudoxochiton huttoni, Pilsbry.
Man. Conch. (1), vol. xiv., p. 194, pl. xlvi., figs. 96-100 (1893).

Revision of the New Zealand *Polyplacophora*, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 183–200, with figs. in text (1897).

Acmæa chathamensis, Pilsbry.
Man. Conch. (1), vol. xiii., p. 56, pl. xxxv., figs. 43–46 (1891).

Acmæa helmsi, E. A. Smith.
Proc. Mal. Soc. London, vol. i., p. 58, pl. vii., figs. 4, 5 (1894).

Patella kermadecensis, Pilsbry.
Nautilus, vol. vii., p. 106 (1894). Proc. Acad. Nat. Sci., Philad., 1894, p. 208, pl. vii., viii.

Scissurella lytteltonensis, E. A. Smith.
Proc. Mal. Soc. London, vol. i., p. 57, pl. vii., figs. 1, 2 (1894).

Trochus oppressus, Hutton, var. *dunedinensis*, Suter.
Proc. Mal. Soc. London, vol. ii., p. 261 (1897).

Monodonta porcifera, Watson (1885).
Suter: Proc. Mal. Soc. London, vol. ii., p. 264, with fig. in text (1897), Radula.

Monodonta coracina, Troschel.
Suter: Proc. Mal. Soc. London, vol. ii., p. 265, with fig. in text (1897), Radula.

Cantharidus sanguineus, Gray, var. *elongata*, Suter.
Proc. Mal. Soc. London, vol. ii., p. 272 (1897).

Photinula suteri, E. A. Smith.
Proc. Mal. Soc. London, vol. i., p. 58, pl. vii., fig. 3 (1894). Suter: *l.c.*, vol. ii., p. 278, with fig. in text (1897), Radula.

Gibbula micans, Suter.
Proc. Mal. Soc. London, vol. ii., p. 279, with fig. in text (1897).

Revision of the New Zealand *Trochidæ*, Suter.
Proc. Mal. Soc. London, vol. ii., pp. 260–283, with figs. in text (1897).

Rissoia hamiltoni, Suter.
Proc. Mal. Soc. London, vol. iii., pp. 2, 3, fig. iv. in text (1898).

Rissoia annulata, Hutton, var. *minor*, Suter.
Proc. Mal. Soc. London, vol. iii., p. 3 (1898).

Rissoia subfusca, Hutton, var. *micronema*, Suter.
Proc. Mal. Soc. London, vol. iii., p. 4 (1898).

Rissoia fumata, Suter.
Proc. Mal. Soc. London, vol. iii., p. 5, fig. i. in text (1898).

Rissoia foveauxiana, Suter.
Proc. Mal. Soc. London, vol. iii., p. 5, fig. ii. in text (1898).

Rissoia lubrica, Suter.
Proc. Mal. Soc. London, vol. iii., p. 5, fig. iii. in text (1898).

Rissoia plicata, Hutton, var. *lyalliana*, Suter.
Proc. Mal. Soc. London, vol. iii., p. 6 (1898).

Barleeia neo-zelanica, Suter.
Proc. Mal. Soc. London, vol. iii., p. 8, fig. v. in text (1898).

Revision of the New Zealand *Rissoiidæ*, Suter.
Proc. Mal. Soc. London, vol. iii., pp. 2–8 (1898).

Paludestrina hamiltoni, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 22, figs. i., ii. in text (1898); Macquarie Island.

Scalaria zelebori, Clessin.
Martini and Chemnitz, Scalariidæ, p. 50 (1897). (The name is preoccupied by Frauenfeld, 1868.)

Scalaria novo-seelandiæ, Clessin.
Martini and Chemnitz, Scalariidæ, p. 57 (1897).

Scalaria reevei, Clessin.
Martini and Chemnitz, Scalariidæ, p. 63 (1897).

Mitra obscura, Hutton (1873).
Suter: Proc. Mal. Soc. London, vol. ii., pp. 201, 202, with fig. in text (1897).

Mitra albopicta, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 21, fig v. in text (1898).

Oncidiella obscura, Plate.
Zool. Jahrb. Anat., vol. vii., p. 207 (1893).

Modiolarca bicolor, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 25, fig. iii. in text (1898); Macquarie Island.

Myrina minuta, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 24, fig. iv. in text (1898).

Philobrya meleagrina, Bernard.
Journ. de Conch., vol. xlv., p. 12, pl. i., fig. 3 (1897); Stewart Island.

Philobrya costata, Bernard.
Journ. de Conch., vol. xlv., p. 15, pl. i., fig. 5 (1897); Stewart Island.

Philobrya filholi, Bernard.
Journ. de Conch., vol. xlv., p. 16, pl. i., fig. 6 (1897); Stewart Island.

Hochstetteria trapezina, Bernard.
Journ. de Conch., vol. xlv., p. 18, pl. i., fig. 7 (1897); Stewart Island.

Condylocardia crassicosta, Bernard.
Journ. de Conch., vol. xliv., p. 175, pl. vi., fig. 1 (1897); Stewart Island.

Condylocardia concentrica, Bernard.
Journ. de Conch., vol. xliv., p. 176, pl. vi., fig. 2 (1897); Stewart Island.

Cyamium oblongum, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 24, figs. viii., ix. in text (1898); Macquarie Island.

Macoma suteri, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 23, fig. vi. in text (1898).

Mactra ordinaria, E. A. Smith.
Proc. Mal. Soc. London, vol. iii., p. 23, fig. vii. in text (1898).

Vanganella taylori, Gray (=*Resania lanceolata*, Gray).
Dall: Proc. Mal. Soc. London, vol. iii., p. 85 (1898), Anatomy.

Zenatia acinaces, Q. and G. (=*Z. deshayesii*, Reeve).
Dall: Proc. Mal. Soc. London, vol. iii., p. 86 (1898), Anatomy.

II.—BOTANY.

Art. XXVI.—*A Description of some Newly Discovered Indigenous New Zealand Ferns.*

By W. Colenso, F.R.S., F.L.S. (Lond.).

[*Read before the Hawke's Bay Philosophical Institute, 10th October, 1898.*]

Class III. CRYPTOGAMIA.

Order I. Filices.

Genus 5. **Hymenophyllum,** Smith.

1. *H. alpinum*, sp. nov.

Plant small, terrestrial, creeping, glabrous, caudex very long, horizontal, intermixed, bare, with a few small fine red hairs scattered on rootlets. Stipe flexuous, suberect, slender, wiry, 2 in.–3 in. long, woody, terete, smooth. Frond tri-subquadripinnate, deltoid, ¾ in.–2 in. long, generally much recurved and compacted, dark-green, frequently possessing reddish spots, and bearing a rusty tinge (red-brown in age); main rhachis bare below, above with subrhachises narrowly winged, serrate; pinnæ irregularly and closely overlapping, ultimate pinnules subflabelliform; lobes narrow-linear, truncate, coarsely serrate; tips sometimes dilated and 2–3 serrulate; single-veined; veins stout, not extending to tips. Involucres very few, solitary, supra-axillary in upper pinnæ, free, substipitate, pale-green; valves rather large, cut nearly to base, oblong; tips broad; margins entire, purplish; receptacle stout; capsules large, compact.

Hab. Ruahine Mountain-range, alpine woods, east side; 1898: *Mr. H. Hill.* Same mountain-range, common; 1845–52: *W. C.*

Obs. I. This species is near *H. truncatum*, Col. (Trans. N.Z. Inst., vol. xxiii., p. 390), but differs from that species in several characters, particularly in its very long, wiry, flexuous, bare, and glabrous stipe, which is also remarkably tough, though extremely slender; its fruiting fronds are very few.

II. This fern is the mountain species referred to above: *l.c.*, p. 391.

2. *H. oligocarpum*, sp. nov.

Rhizome long, wiry, harsh, creeping, blackish, bare, with a few rootlets. Stipe 2¾ in.–3 in. long, filiform, wiry, naked, dark-brown. Frond erect, ¾ in.–1 in. apart, glabrous, subovate-acuminate, 2½ in.–3 in. long, 2 in.–4 in. wide, rather irregular in outline, bipinnate, membranous, decurved, bright emerald-green; pinnæ free; midrib, rhachis, and subrhachises prominent, slender, blackish throughout, winged, denticulate-serrate, the wings of subrhachises broader, secondary pinnæ rather distant; lobes linear, sharply serrate, teeth distant, tips obtuse-truncate, sometimes denticulate. Involucres large, few, solitary, supra-axillary in upper secondary pinnæ, and extending to tip of frond, free, pedicelled, erect and drooping; pedicel often winged on one side, with a short lobe or tooth on the other; valves large, broadly obovate, entire, smooth, shining, cut half-way down, immature closed and much curved together, mature open, gaping. Receptacle stout, largely exserted; capsules few, red.

Hab. Forests, Waikaremoana, Hawke's Bay; 1898: *Mr. H. Hill.*

Obs. A species allied to *H. multifidum*, but differing in several characters, particularly its irregular and open pinnæ and pinnules, its few solitary pedicelled sori, and largely decurved involucre; the cells, too, of its frond are different, as shown in the plate of the type specimen of *H. multifidum*, Sw. (Hk. and Grev., Ic. Fil., t. 167), and Baker describes its sori: "1 to 12 to a pinna, terminal on the lateral segments of the upper pinnæ on both sides" (Sy. Fil., p. 69).

Genus 18. **Asplenium**, Linn.

1. *A. symmetricum*, sp. nov.

Plant small, tufted, upright, drooping; rootstock compact, 8–10 fronds. Stipe 1 in. long, greenish, subsucculent, thickish, clothed at base with long deltoid acuminate scales. Frond subovate-lanceolate, 3 in. long, 1 in.–1¼ in. wide, bipinnate, membranaceous, glabrous, dark-green; rhachises sealy, and pinnæ sparsely so, with smaller scattered scales; pinnæ alternate, oblong, obtuse, regular, 9–10-jugate, close but not overlapping, each having 3–4 pairs of pinnules; pinnules all stalked and distant, free throughout, cut to base into 4–5–6 lobes; the lowermost pinnule on upper side of subrhachis, and always the largest, 6-lobed; lobes long, linear and linear-lanceolate, flat, narrowly margined, very acute, rarely bifid, tips pointed, single-veined; veins central, not extending to margins, their tips prominent on upper surface, white. Sori general throughout; one cluster on vein in each lobe red. Involucre rather large, white, oblong-lanceolate, ends acute;

margins entire, very thin, not extending beyond margin of lobe. Scales (basal) deltoid-acuminate, 3 lines long, their margins distantly serrate-lobed, tips very narrow-elongated; cells large, unequal, parallelogrammatic, and extending to tips, their margins black and very stout.

Hab. Hills (altitude 2,000 ft.) near Rangiora, North Canterbury; 1898: *Mr. T. Keir.*

Obs. This strikingly neat little fern is allied to *A. colensoi*, Hook. f., with which it has been hitherto classed, but is very distinct in many particulars—in colour, size, form, and general appearance; its pinnæ are more regular and closer, all pinnules free, many-lobed, and stipitate; scales larger and differently shaped.

Genus 8. **Cystopteris,** Bernh.

1. *C. laciniatus*, sp. nov.

Plant terrestrial, tufted, suberect and drooping, membranaceous, glabrous, light-green. Stipe slender, flattish above and slightly canaliculate, subsucculent, pale, 3½ in.–4½ in. long, a few small scales and reddish hairs at base and scattered scales a short distance up stipe; scales very delicate, light-brown, ovate-acuminate-caudate. Frond ovate and ovate-deltoid, much acuminate, 6 in.–8 in. long, 4 in.–4½ in. wide, bipinnate (subtripinnate lower pinnæ); pinnæ subopposite, patent, horizontal, loose, distant below closer above, rhachis very slender; pinnules distant, stipitate, pinnatifid, deltoid-acuminate, acute, lowermost with 8–10 segments; segments stipitate, ovate, obtuse, decurrent; secondary segments ovate, deeply cut or lobed; lobes irregular, laciniate, sharply toothed, tips truncate and bifid, veined; veins white, decurrent, and collateral on stipes of pinnules. Sori numerous, small, distant, scattered, blackish, shining, central on vein, regular, 2–4 on a segment, extending to ultimate lobe. Involucre small, oblong, tip obtuse, retuse, sometimes bifid and lacerate, very membranous, white, shining, sparsely echinate, margins entire; at first covering sorus.

Hab. North Canterbury, New Zealand; 1898: *Mr. T. Keir, Rangiora.*

Obs. It is not without some doubt, and much research and long examination, that I describe this fern as a new species, for it is certainly pretty closely allied to *C. fragilis*, Bernh., and its varieties. It differs, however, considerably from them all, and did I not possess ample correct botanical drawings with dissections of them (Hooker's "British Ferns" and "Flora Tasmaniæ," Beddome's "Ferns of British India," &c.) I should hesitate to do so. This fern, however, is much larger, and possesses characters which those ferns do not,

particularly in its stipitate pinnules, which are also largely laciniate, with lobes bifid and sharply toothed, and in its involucre, which is much more oblong and obtuse with entire margins; whereas in *C. fragilis* and all its varieties their involucres are always shown broadly ovate, their bases largely rounded, very acuminate, with finely serrulate margins. Hooker refers to his figure of the Tasmanian fern (*C. fragilis*, var. *β*) as being identical with the known and described New Zealand species or variety; but that is widely different from this plant.

Art. XXVII.—Phænogams: *A Description of a few more Newly Discovered Indigenous Plants; being a Further Contribution towards the making known the Botany of New Zealand.*

By W. Colenso, F.R.S., F.L.S. (Lond.), &c.

[*Read before the Hawke's Bay Philosophical Institute, 10th October, 1898.*]

Class I. DICOTYLEDONS.

Order I. Ranunculaceæ.

Genus 1.* **Clematis**, Linn.

1. *C. hillii*, sp. nov.

Branches very long and slender, climbing; bark dark-purple, striate, ribbed. Leaves and flowers together at regular distances 3 in. apart, opposite on branches. Leaves on slender petioles sub 3 in. long, densely hairy; leaflets small, ternate, petiolulate, broadly ovate, sometimes suborbicular, ½ in. (rarely ¾ in.) long, margins entire, sometimes irregularly cut and serrate, base dimidiate; green; veined, veins prominent and dark on under-surface; veinlets anastomosing; hairy on both surfaces, hairs shining, pale ferruginous, petiolules very slender, 2–3 lines long. Flowers few, often 3 together in short panicles; peduncles and pedicels stout, densely pubescent. Sepals 5, tawny, very silky-hairy on outside, subovate-lanceolate, obtuse, tips truncate and jagged; 5-veined; veins dark. Stamens numerous, 20 or more; filaments linear-lanceolate; anthers suborbicular or broadly elliptic, flat, tips very obtuse.

Hab. Forests, slopes Ruahine Mountain-range, east side; October, 1898: *Mr. H. Hill.*

* The numbers of the orders and genera given here are those of them in the "Handbook of the New Zealand Flora."

Obs. I. A distinct species, allied to *C. parviflora*, but widely different in sepals and anthers.

II. Named in honour of its discoverer, Mr. Henry Hill, F.G.S., Inspector of Schools, who has often visited that mountain region, bringing therefrom many of its botanical novelties, described by me in papers in the Transactions.

Genus 3. **Ranunculus**, Linn.

1. *R. uniflora*, sp. nov.

Plant very small, perennial, tufted, erect, spreading, about 1 in. high. Rootstock hard, woody; rootlets few, wiry, descending. Leaves few, 4–6, subdeltoid, 2–3 lines long, trifoliolate; lobes suborbicular, sessile, entire, terminal one largest, 1–1½ lines broad, lateral much smaller, thickish, veins obsolete, light-green; petioles ½ in.–¾ in. long, stout, sheathing half-way up; sheaths large, membranous, white. Flowers solitary, one on each plant; scape stout, shorter than petioles, with a spathe-like bract encircling stem a little below calyx, white, membranous. Sepals 3, suborbicular, very thin, pale-yellow. Petals 4, yellow, shining, obovate-spathulate; claw narrow; nectary below middle, foveolate. Filaments short; anthers elliptic. Achenes few, turgid, roughish; tips filiform, curved; head of fruit small, green.

Hab. Waikaremoana, Hawke's Bay; October, 1898: *Mr. H. Hill*.

Obs. A species near *R. acaulis*, Banks and Solander, but differing in several characters—*e.g.*, not stoloniferous, leaflets always entire, petioles largely sheathing, scape with a bracteolate spathe under calyx, petals fewer and differently shaped, and achenes roughish. In size, too, it is much smaller than *R. acaulis*. This very small size is general; I have upwards of a dozen plants, which are nearly alike. I may further remark that *R. acaulis* is largely delineated with dissections in Hooker's "Flora Antarctica": Auckland and Campbell Islands, vol. i.

Order III. Cruciferæ.

Genus 4. **Cardamine**, Linn.

1. *C. xanthina*, sp. nov.

Plant herb, perennial, small, depressed; leaves spreading horizontally, subrosulate; root long, thick, white, tapering. Leaves radical, numerous, imbricate, with a few on flowering-stem near its base, glabrous and slightly hairy, spathulate-acute, 1½ in.–2½ in. long, membranous, much and deeply cut, sinuate-lobed, subpinnatifid; lobes regularly opposite their margins, variously cut and toothed, decreasing gradually to

petiole; petiole $\frac{3}{4}$ in.–1 in. long. Flowering-stems (several) horizonal and suberect, 5 in.–7 in. long, terete, slender, greenish and purple, having (with pedicels) curious small scattered white hooked hairs reversed. Flowers few, solitary, 2–3 scattered on stem from middle upwards on long slender pedicels and 4–6 together forming a small loose corymb at top. Calyx sepals 4, oblong, green-purple striped, subechinate, 2 outer slightly concave, their tips obtuse and involute, 2 inner tips acute, with membranous white margins. Corolla 5 lines diameter, bright-yellow, patent, shining, flat, vertical; limb suborbicular-obovate, gradually decreasing from below middle to base; tip slightly truncate. Stamens stout, 4 long, 2 short; style $1\frac{1}{2}$ lines long, stout, erect (with pod), as long as long stamens; stigma large, circular, densely pubescent. Pod $\frac{3}{4}$ in.–1 in. long, linear-subterete, slightly compressed. Seeds oblong, light-brown, smooth.

Hab. Napier, in house-paddock; flowering October, 1898: *W. C.*

Obs. I. This little plant has caused me much research and diligent examination, not only from its being wholly new to me, but from its bright-yellow and striking flower, its long style, its large bushy stigma, and its subterete pod; so that it scarcely belongs to the true *Cardamine* genus, as laid down by Bentham and others—*i.e.*, flowers "white," pods "flat," and seeds "pitted"—notwithstanding its resemblance—*primâ facie*—to some of Sir J. D. Hooker's Auckland and Campbell Islands *Cardamine*—as given in his drawings of them in his Flora of those islands—is very great. Moreover, while Bentham says of the genus the flowers of *Cardamine* are "white" (and certainly all our known southern species are so) and their seeds "pitted," yet we have a British *Cardamine* with coloured flowers—*e.g.*, *C. pratensis;* and *C. purpurea*, a North American species, has dark-purple flowers; and I notice in the "Index Kewensis" a *C. flavescens*, which, not knowing it, I suppose to have yellowish flowers; and Bentham himself, in his "Flora Australiensis," describes four species of Australian *Cardamine* with their seeds "not pitted" (*l.c.*, vol. i., pp. 69, 70); and Hook. f., in his ample descriptions of the *Cardamine* of Auckland and Campbell Islands, describes two species as having pods "*linearibus compresso-tetragonis.*"

II. Further, I am not certain of my plant being truly indigenous, for, were it so, I must surely have noticed its striking open bright-coloured flower attracting notice. Last year I found three small plants, distant from each other, growing in the side of the pathway to my house, which, from their appearance, were from the year before. This pathway had been then—in the former year—cleared out and laid down thickly with limestone gravel from the quarry. At first sight I

supposed them to be shepherd's purse (*Capsella bursa-pastoris*), which grows here plentifully; and I am pretty certain this plant is not of any described Australian cruciferous genera. I have, however, now plenty of specimens, and shall send some shortly to Kew for examination.

Order XXVI. Droseraceæ.

Genus 1. **Drosera,** Linn.

1. *D. ligulata*, sp. nov.

Plant perennial, small, suberect, 1 in.–1½ in. high; rootstock thickish, hard, black, much branched; branches finely and thickly woolly-hairy. Leaves radical, few, erect and spreading, thickish, linear, 9–10 lines long, $\frac{1}{10}$ in. wide, red and reddish-green, tip obtuse, subapiculate, knobbed on upper surface, and shining, the apical half or more glandular above; glands long, erect, spreading, flat, white, their tips dark-red, ciliate at margins, the central ones sessile; petioles long, bases widening, enwrapping, membranaceous, nerved. Scape erect, slender, bare, as long as leaves or longer, rarely shorter, black (also calyx), 1-flowered (one specimen bore 2 scapes, one being much smaller). Calyx longer than corolla, sepals cut nearly to base, oblong, subacute. Corolla, petals oblong, membranous, nerved, tips obtuse, pale-brownish (dried). Stamens as long as petals, slender, spreading, curved; anthers elliptic, whitish or pale-yellow. Styles 3, stout; stigmas large, suborbicular, thickish. Ovary large, broadly oblong, longer than calyx, shining.

Hab. Ruahine Mountain-range, in low-lying wet spots; 1898: *Mr. A. Olsen.*

Obs. A species having affinity with *D polyneura*, mihi (Trans. N.Z. Inst., vol. xxii., p. 460).

2. *D. atra*, sp. nov.

Plant small, perennial, erect, 1 in. high, bearing 7–8 leaves; rootstock thick, bushy, roots many, wholly blackish save corolla. Leaves radical, sub 1 in. long, spathulate, limb 4–5 lines long, densely glandular the whole upper surface, glands long and dark; petioles slender, ¾ in. long, nerved. Scape erect, slender, bare, 1-flowered. Calyx-lobes cut one-third length, large, broad, truncate, margins of tips serrulate-crenulate. Corolla white, twice as long as sepals. Stigma large, tuberculate.

Hab. Ruahine Mountain-range, east side, wet spots near summits; 1898: *Mr. A. Olsen.*

Obs. Only one specimen received—among other plants *in situ*—but a good one; and, while near the preceding species, bears differential characters.

Order XXXVIII. Rubiaceæ.

Genus 1. **Coprosma**, Forst.

1. *C. lanceolata*, sp. nov.

A large shrub or small tree (specimens); branchlets stout, woody, 6 in.–8 in. long, wholly glabrous; bark pale-brown, smooth, regularly scarred sub 1 in. apart, the main branch having an angled subtetragonal form. Leaves 8–12 at top, rather distant, loose, spreading, shining, subrecurved, lanceolate, 5½ in. long (including petiole), 1¼ in.–1½ in. wide; tip very acute produced; base tapering, subcoriaceous, margins plain, very slightly uneven, dark-green above, pale below; veins 7-jugate; veinlets largely anastomosing; midrib prominent on both surfaces; petiole 1 in. long, stout, firm, smooth above, not furrowed, connate at base with stipules; stipules large, deltoid, broad and sharply pointed, cuspidate. Flowers not seen. *Fœm.:* Fruit (immature) subterminal, axillary on long peduncles ½ in.–¾ in. long, usually 3 drupæ together (sometimes 2 or only 1), sessile, with two long linear bracteoles at base. Drupæ broadly elliptic, 4 lines long, smooth, shining, with hollow crown. On same specimens higher up young undeveloped flower-buds—*alabastron*—on stout peduncles ¾ in. long, each bearing three small clusters or fascicles, 2 on lateral subpeduncles opposite and containing 3 each, and the central one 5, all alike compact, sessile, erect, ovoid, every one enclosed in a simple cup-like calyx or perianth, showing at top 4–5 closely packed flowers, each cluster having a pair of long linear green leafy bracteoles at base.

Hab. Thickets, slopes Ruahine Mountain-range, east side; 1898: *Mr. H. Hill.*

Obs. This plant, though specimens received were incomplete, is so greatly diverse in its foliage and striking general appearance from all other *Coprosmæ* known to me that I have no hesitation in describing it as a *species nova.*

2. *C. sagittata*, sp. nov.

Shrub 8 ft.–10 ft. high, erect and diffuse (specimens 1 ft.–2 ft. long, straight); branches slender, glabrous; bark pale, smooth. Leaves submembranous, various in size, distant, scattered, glabrous, green above, rather dull, not shining, pale below, the largest 1 in. long ½ in. wide, the smaller and more numerous less than half that size, broadly lanceolate, oblong, acute and obtuse, base cuneate, tapering nearly to base of petiole; veins few—usually 5-jugate—foveolate; midrib prominent, lower half above; veinlets curiously and closely anastomosing; petioles narrow, 2–3 lines long,

when young green and subsucculent, closely dotted with red; stipules rather large, broad, glabrous, with narrow erect teeth, 2 being longer. Flowers single, axillary on short opposite branchlets, which are often forked at top, each having 2 small leaves with a flower between them; calycine bracts 2, erect, leaf-like. *Masc.:* Corolla bell-shaped, greenish dashed with purplish streaks, shining, 4 lines long, 6-lobed; lobes cut half-way down, subovate, acute, 1-nerved, spreading, revolute, stamens 6, largely pendulous; filaments ½ in. long, dark, flaccid, pubescent; anthers 3½ lines long, linear, pale with a dark nerve running throughout, tip acuminate-apiculate; base largely sagittate, sharply acute. *Fœm.* (immature): Fruit only seen, solitary, sessile, suborbicular, green, shining, 1½ lines diameter.

Hab. Forest near Dannevirke (barren); 1892: *W. C.* Slopes Ruahine Mountain-range; 1898: *Mr. H. Hill.*

Obs. A species near *C. fœtidissima,* but differing in several characters, particularly in its peculiar long linear anthers apiculate and sharply sagittate produced. Forster, who discovered and described *C. fœtidissima,* establishing the genus on it, gives a dissection of its flowers showing a very differently formed anther, &c. ("Genera Plantarum," tab. 69).

Order XXXIX. Compositæ.

Genus 6. **Brachycome,** Cass.

1. *B. alpina,* sp. nov.

Plant small, slender, slightly hairy, simple (sometimes 2-branched); rhizome, 3 in. (and more) long, filiform. Leaves radical, scattered, suborbicular, 4 lines diameter, tapering, faintly crenate-lobed, lobes few, their tips pointletted-hardened from vein produced, dark-green above, paler below, membranaceous, much veined; hairs sprinkled, appressed, substrigillose, white, flat, subulate, strangulated, thicker on upper surface; petioles very slender, 1 in. long, canaliculate and dilated at base with membranous margins and patent hairs, dark purple-brown. Scape erect, 3 in.–3½ in. long, filiform, with 2–3 small linear distant bracts, glabrous but pubescent towards tip. Head small, drooping, 2 lines diameter. Involucral scales numerous, sub 20, linear, dark-green with a thick purple central nerve, margins membranaceous, white; tips acute, jagged. Florets few; ligulæ white, revolute. Receptacle broad, naked, shining, alveolate. Pappus 0. Achene sublanceolate, $\frac{1}{10}$ in. long, slightly glandular, viscid.

Hab. Ruahine Mountain-range, east side; Feb., 1898: *Mr. H. Hill.*

Genus 17. **Senecio,** Linn.

1. *S. tripetaloides*, sp. nov.

A small, neat, upright shrub, 2½ ft.–3 ft. high, bushy above, main stem 1½ in. diameter; bark grey. Branchlets—peduncles and involucres—greenish, very slightly scurfy and glutinous. Leaves alternate, rather distant and confined to ends of branchlets, petiolate, broadly lanceolate or narrow-oblong, obtuse, slightly tapering, 1½ in.–2 in. long, 9–11 lines broad (some smaller), coarsely and irregularly serrate, membranaceous, glabrous, light-green, paler below with scanty fine white scurf; veins white, largely anastomosing on upper surface; petioles ½ in. long, subterete, canaliculate, stoutish, pale-green. Flowers rather numerous, terminal, subcorymbose, loose, on long axillary slender peduncles 1 in.–2 in. long, each usually containing 5 (rarely 4–6) heads of florets on long slender pedicels ½ in.–1 in. long, each having a leaf-like bract at base and a small linear appressed bracteole (sometimes 2–3) at base of involucre. Heads small, ½ in. diameter, bright-yellow. Involucre erect, cylindrical, 3 lines long; scales 5, linear-oblong, 3-nerved, margins membranous, broad; tips obtuse, ciliolate. Ray-florets 3, spreading, equidistant; ligulæ broadly elliptic, ¼ in. long, tip obtuse, slightly 3-notched, smooth, subconcave, obsoletely many-nerved; style short, one-third length of ray, slender, curved, obtuse. Disk-florets 5, 5-lobed; lobes 3-ribbed, largely revolute; style long, much produced, stout, obtuse, curved. Pappus numerous, erect, length of tube of disk-florets and longer than involucre, scabrid, obtuse, white.

Hab. "Tatapouri" Hills, on east coast, ten miles north from Poverty Bay; also (earlier) north of East Cape: *Mr. H. Hill.*

Obs. I. The affinities of this plant are with *S. glastifolius*, Hook., though very distinct. The heads present a peculiar appearance from each having only three spreading divergent ray ligulæ.

II. The description is taken from living specimens in Mr. Hill's garden, Napier, flowering November, 1897.

Order XL. Stylidieæ.

Genus 1. **Forstera,** Linn.

1. *F. major*, sp. nov.

Plant wholly glabrous, main stems 8 in. long, stout, naked, succulent, dark-reddish, forked; 2 branches, one 3 in. and one 2 in. long, stout, each having 2 branchlets of 2 in.–3 in. in length; branches and branchlets very leafy. Leaves close and spreading, broadly oblong, ¼ in. long, subsessile, tips

thickened with a circular pore above, light-green, margins recurved. Flowers terminal, on a long slender erect scape 2 in. long, bearing 2 flowers on short pedicels with 5 bracts at their bases half as long as perianths; bracts linear-lanceolate-obtuse, reddish-green (as also calyx), their tips slightly ciliolate. calyx-lobes oblong, 1-nerved, tips knobbed. Corolla longer than calyx, lobes broadly oblong-obtuse, membranaceous. Column summit subreniform, longitudinally trisulcated, ovary dark-reddish.

Hab. Ruahine Mountain-range, east side; 1898: *Mr. H. Hill.*

Obs. A much larger and stouter plant in all its parts than *F. sedifolia*, from the same locality, and nearly allied to *F. truncatella*, mihi (Trans. N.Z. Inst., vol. xx., p. 196).

Order XLI. CAMPANULACEÆ.

Genus 1. **Wahlenbergia**, Schrader.

1. *W. pygmæa*, sp. nov.

Plant very small, ½ in. high, simple, tufted, glabrous; root 2 in. long, slender, hard, white; sometimes 2–4 branches (tufts) rising distantly from one long branched root. Leaves radical, numerous, sub 20, close, spreading, somewhat verticillate, linear-spathulate, 4 lines long (including petiole), 1 line broad, tip rounded very obtuse, with 2 small crenulate serratures on each side, tapering gradually to base, pale-green, shining. Flower large (for plant), solitary, terminal, drooping; scape ½ in.–¾ in. high, very slender, bare. Calyx campanulate, 2 lines long, dark-green, 5-lobed; lobes cut halfway down, linear-acuminate-obtuse, 1-nerved. Corolla 5 lines long, sub ½ in. diameter, white, lobes pale-blue, 2-nerved, triangular, subacute, half length of corolla. Style flat, 2-nerved, densely minutely tuberculate on each side and upwards to top of stigma; stigmas 2, oblong-lanceolate.

Hab. Ruahine Mountain-range, west side, near summits; 1848: *W. C.* East side; 1898: *Mr. A. Olsen.*

Obs. This is a peculiarly striking little plant, from its uniform size and pleasing appearance, a rather large drooping bell-flower springing from its little squarrose moss-like tuft of leaves. As I first made its acquaintance in its alpine habitat fifty years ago, and sent specimens to England—probably not quite perfect—I think it may have been considered as identical with *W. saxicola*, A. DC., but that plant is different in several characters; a good drawing of it, with dissections, is given by Sir W. J. Hooker in "Icones Plantarum" (tab. 818), under the name of *W. albomarginata*.

Order XLII. Ericeæ.

Genus 1. **Gaultheria**, Linn.

1. *G. calycina*, sp. nov.

Shrub (from specimen, apparently erect growth), branch 5 in. long, subflexuous, slender, 1 line diameter; outer bark silvery-grey, longitudinally furrowed, bearing 7 branchlets at top 1½ in.–2 in. long, dark-red, glabrous, very leafy. Leaves numerous, suberect and spreading, oblong-lanceolate, 8 lines long, 3 lines broad, flat, margins serrulate, teeth blunt; tip subacute, thickened, a little knobbed; base slightly tapering; pale-green, much veined on both surfaces, veins anastomosing, translucent; petioles sub 1 line long, stout, red. Flowers terminal in small corymbs 1 in.–1½ in. diameter; peduncles much bracteolate, bracts pale-green, deltoid-ovate-acute, patent, pedicels stout, 1 line long, curved, with 2–3 spreading bracts at base. Calyx rather large, inflated, pale-green, 5-lobed; lobes ovate, acute, thin, margins entire. Corolla tubular, red, 2 lines long, 5-lobed; lobes small, recurved, obtuse.

Hab. Ruahine Mountain-range, east side; 1898: *Mr. A. Olsen.*

Obs. A species having affinity with *G. glandulosa*, mihi (Trans. N.Z. Inst., vol. xxviii., p. 600).

Genus 2. **Pernettya**, Gaud.

1. *P. polyphylla*, sp. nov.

Plant a small twiggy glabrous under-shrub, semi-prostrate and suberect; branches spreading, 4 in.–5 in. long, slender, bearing many short branchlets, which are sometimes branched, ½ in.–¾ in. long, subsecund, and erect. Leaves numerous and closely set on tips of branchlets, quadrifariously disposed, subdecussate, erect, imbricate, linear-lanceolate, sub 2 lines long, margins entire, 3-nerved, tips obtuse, thickish, pale-green; petiole ½ line long, stout, reddish, terete, swollen at base. Flowers few, terminal, solitary on tips of branchlets; peduncle short, bracteate; bracts broadly ovate, pale-brown, appressed. Calyx small, lobes ovate-acuminate, tips minutely ciliolate, margins membranous, finely serrulate. Corolla linear-tubular, 2 lines long, reddish-brown, slightly hairy within; lobes one-third length, linear-acuminate-acute, recurved, densely woolly-pilose with white hairs, smooth, shining without. Anthers included, linear-oblong, dark-red. Style shorter than anthers; stigma capitate. Fruit globular, size of a small pea, dark-red, shining, style persistent.

Hab. Ruahine Mountain-range, east side, secondary summits; 1898: *Mr A. Olsen.*

Obs. A strikingly neat little plant, with showy fruit.

Genus 8. **Dracophyllum,** Lab.

1. *D. brachycladum*, sp. nov.

Apparently from specimens a medium-sized shrub; specimens 5 in.–8 in. long: one specimen—branchlets 18–20, subverticillate, 2 in.–3 in. long, crowded on top of branch; and in another specimen extending on main branch 1 in. apart—erect, very slender, ½ line or less wide; bark reddish-brown, glossy, irregularly and deeply ringed. Leaves 10–12, terminal, opposite, loose, open, spreading, filiform, sub 1 in. long (decreasing in length upwards), $\frac{1}{25}$ in. wide, 1-nerved, much recurved throughout their whole length, their bases greatly enlarged, 1½ lines wide, and many-nerved. Flowers terminal, erect, 5–6 together in a short broad spike 6–9 lines long; calycine bracts nearly as long as flowers, their bases large wrapping, tips suddenly acuminate, subacute. Calyx narrow, sublinear-acuminate, tip acute, longer than style. Corolla red, narrow tubular, 3 lines long, expanded at base, and many-nerved (10); lobes 5, half as long as tube, deltoid, recurved, 1-veined, tips acute, margins incurved. Anthers narrow-oblong, margins straight parallel, base and apex abrupt truncatulate. Style 1 line long, stout; stigma rounded, black, smooth, shining. Scales small, half as high as capsule, broadly cuneate, apex rounded.

Hab. Ruahine Mountain-range, east side; 1898: *Mr. H. Hill.*

Obs. A species near *D. rubrum*, Col. (Trans. N.Z. Inst., vol. xx., p. 200), and also near *D. tenuicaulis*, Col. (vol. xxii., p. 476).

Order L. Boragineæ.

Genus 1. **Myosotis,** Linn.

1. *M. polyantha*, sp. nov.

Plant perennial; rootstock thick and bushy, with many long fine roots and rootlets, blackish. Leaves many, radical, petiolate, broadly oblong, 8 lines long, 5 lines broad (some smaller), apex subacute, base tapering, much veined; petioles 9 lines long, very slender; upper surface closely covered with white sparkling dots, from each a single hair springs. Flowering-stems several, 8 in.–10 in. long, forked, spreading, leafy two-thirds of length; leaves similar to radical but smaller, and becoming gradually less in size upwards; each raceme bearing 8–15 rather distant flowers; pedicels slender, 1 line long. Calyx green, coarsely veined, rough with short hairs arising from white circular dots, as in leaves; lobes cut half-way down, linear-ovate; tips sharply acuminate, ciliate hairy. Corolla small, 2 lines long, 1½ lines diameter, veined; scales small, narrow. Anthers ovoid, obtuse, cordate-

acuminate. Style very long, longer than calyx; stigma small, clavate.

Hab. Ruahine Mountain-range, east side; February, 1898: *Mr. H. Hill.*

2. *M. tenuifolia*, sp. nov.

Plant small, erect, hispid; roots numerous, long, woody, wiry, blackish. Leaves radical, spreading; flower-stalk 3 in.–5 in. high, solitary, slender, sometimes two from one root; hairs white, strigose, scattered on leaves but close on stalk. Leaves radical, 6–8, petiolate, limb broadly oblong, ½ in. long, 4 lines wide, smaller ones suborbicular, thin, margins entire; petioles slender, sub ½ in. long, dilated at bases; on stem, 4–6, the lowermost pair opposite, petiolate; others sessile, smaller, scattered, alternate. Flowers terminal on raceme, 6–10, distant, pedicelled; pedicels slender, 1½ lines long. Calyx green, campanulate, 2 lines long; lobes cut halfway down, spreading, ovate-acuminate, tips acute, 3-veined, margins ciliate; hispid on veins, which are ridged and coloured. Corolla small, pale-pinkish; tube cylindrical, narrow; lobes large, rounded, veined. Scales of throat reniform, margins entire. Stamens short; anthers narrow ovate-cordate, tips produced above scales, obtuse. Style long, exserted; stigma small, globose. Nuts orbicular, light-brown, shining, slightly margined.

Hab. Ruahine Mountain-range, east side; 1898: *Mr. A. Olsen.*

Order LIII. Scrophularineæ.

Genus 7. **Veronica**, Linn.

1. *V. truncatula*, sp. nov.

Shrub small, glabrous; branchlets erect, opposite, woody, slender, 2½ in.–3 in. long, $\frac{1}{12}$ in. diameter, regularly ringed, scars $\frac{1}{10}$ in. distant; bark grey, longitudinally furrowed. Leaves terminal, rather numerous, 12–15, patent, spreading, sub narrow-ovate, 1 in. long, 2–3 lines wide, sessile; tip truncate, thickened; midrib rather prominent below; submembranaceous, light-green. Flowers small and closely set in a narrow subterminal raceme, 1 in. long, pedicelled; pedicels ½ line long; bracts small, oblong. Calyx small, 1 line long, 4-lobed; lobes oblong, obtuse, pale-green, 1-nerved, with white membranous margins. Corolla small, 2 lines diameter, white; lobes nearly equal; tips rounded. Stamens excluded; anthers subcordate, tips acute; style erect, straight, longer than stamens; stigma capitate.

Hab. Ruahine Mountain-range, east side; February, 1898: *Mr. H. Hill.*

Obs. I do not know of any New Zealand species of this

genus that this one is closely allied to, or may be compared with. At first sight its pale-green narrow foliage reminded me of some species of *Pimelea*. Its small close-set flowers, with their light-green calyces bordered white, and clear light-green narrow leaves with their peculiar truncated tips, are good characters.

2. *V. azurea*, sp. nov. (*non* Link.).

Shrub erect, branched, glabrous; branches generally having 3 short terminal branchlets, deeply and regularly ringed $\frac{1}{15}$ in. apart; branchlets slender, sub 2 in. long, 1 line diameter; leaves at tips subdistichous, 12–14, crowded, erect, ovate, 4 lines long, 2 lines broad, subsessile, subcoriaceous, strongly keeled; tip subacute semi-knobbed by the stout prolonged midrib; expanding at base, and closely appressed to branchlet; slightly concave and transversely wrinkled on upper surface at base. Flowers terminal in short compact corymbs of 4–5; pedicels 1–1½ lines long; bracts broadly ovate. Calyx as long as tube; lobes large, oblong, obtuse, slightly ciliolate. Corolla clear bright-blue, 3 lines diameter, limb-lobes rather large, nearly equal; tips of the 2 lateral ones and lower lobe rounded, of the upper subacute; tube 1 line long. Stamens stout, excluded; anthers largely cordate. Style longer than stamens, flexuous; stigma small, coloured, simple.

Hab. Ruahine Mountain-range, east side; February, 1898: *Mr. H. Hill.*

Obs. A striking and neat species from its small symmetrical foliage and its pretty bright-blue flowers—a colour rather rare in our New Zealand *Veronicæ*. Its nearest alliance is, I think, with *V. buxifolia*, Benth.

3. *V. polyphylla*, sp. nov.

A small low diffuse undershrub; branches hairy, long; branchlets woody, ascending, slender, 1½ in.–2 in. high. Leaves on top of branchlets, small, numerous, close, spreading, suborbicular, 2 lines diameter (some much smaller), thickish, margins deeply crenate and subrevolute, their lobules thickened, glabrous, apical lobe large and very obtuse, base tapering, slightly hairy underneath and wrinkled; petioles 1 line long, slender; hairs short, scattered. Flowers rather large for plant, terminal, generally 2 together on separate peduncles, 1 line long, with very small subspathulate leaves at bases and between them. Calyx, sepals 4, cut nearly to base, linear, thick, obtuse, irregular in width. Corolla pale, whitish, 2 lines diameter, upper and 2 lateral lobes large, the lower smaller, all much veined, with tips rounded. Stamens short, curved; anthers large, suborbicular, cordate, flattish, pale, included.

Hab. Ruahine Mountain-range, east side; 1898: *Mr. A. Olsen.*

4. *V. subrosulata*, sp. nov.

Plant very small, main stems slender, prostrate, subwoody, with little branches erect, 1 in.–2 in. apart, rising sub 1 in. and each bearing 2–3 minute branchlets, and each branchlet crowned with 10–12 minute leaves. Leaves close, subrosulate, and subimbricate, subobovate-orbicular, $\frac{1}{16}$ in. long, tapering, thickish, undulate-crisp, deeply crenate, margins much recurved, green above, brown and longitudinally rugulose below, very hairy (with young stems and calyces); hairs scattered, curved, white; petioles stout, nearly as long as leaves. Flowers large for plant, terminal, 2 together, each on a very short peduncle. Calyx 4-lobed, lobes oblong, very obtuse, margins straight-parallel, ciliolate. Corolla pure white, 4-lobed, the 2 lateral and upper lobes broadly obovate or suborbicular, the lower lobe small and narrow, entire; tube short. Stamens short; anthers large, orbicular, dark-purple, scarcely excluded. Style erect; stigma subcapitate.

Hab. Ruahine Mountain-range, east side; February, 1898: *Mr. H. Hill.*

Obs. An interesting little species—a gem!—pretty near *V. vulcanica*, mihi (Trans. N.Z. Inst., vol. xx., p. 203), which is also an alpine plant, but differing in several characters.

5. *V. subsimilis*, sp. nov.

Shrub low and thick-growing; upper branches suberect and stout, cylindrical, scarred, $\frac{1}{4}$ in. diameter, thickly branched at top; branchlets square, erect, subsecund, 1 in.–2 in. long, $\frac{1}{12}$ in. diameter, leafy throughout; secondaries decreasing gradually in length upwards, so that their tips are nearly even, mostly simple, sometimes forked. Leaves quadrifarious, symmetrical, subvertical, deltoid, $\frac{1}{15}$ in. long, obtuse, sessile, connate, closely imbricate and adpressed, concave above, glabrous, thick, backs rounded not keeled; green, thickly dotted, dashed with red in age, the lower margins of young leaves densely mealy-white, subciliolate. Flowers small, crowded 3–4–6 together at tips of branchlets, sessile. Calyx-lobes oblong, very obtuse, tips rounded, obsoletely 3-nerved, submembranous, light-green, margins slightly incurved, densely ciliolate-woolly, wool-white. Corolla white, $\frac{1}{8}$ in. diameter, 4-lobed, lobes spreading, the two lateral and upper elliptic tips broad suborbicular, the upper lobe largest tip entire, lower lobe small; tube shorter than limb. Anthers suborbicular, large, much exserted. Style longer than stamens; stigma simple.

Hab. Ruahine Mountain-range, east side; February, 1898: *Mr. H. Hill.*

Obs. A species *primâ facie* very like *V. tetragona,* Hook., and without dissection or careful comparison would be taken for it; but it differs in several particulars—as in leaves not keeled and tips rounded; calyx-lobes, tips rounded; corolla tube short; and upper lobe of limb entire, not bifid.

Order LXVII. Thymeleæ.

Genus I. **Pimelea,** Banks and Solander.

1. *P. montana,* sp. nov.

Shrub, branches (specimens) 6 in. long, erect, stout, 2 lines diameter, bark chocolate-colour; branchlets woody, erect, slender, 2½ in. long, 1 line diameter, closely and regularly scarred, thickly black muricated between scars, with many short secondary branchlets at their tips 1 in.–1½ in. long, very leafy; the young branchlets densely clothed with coarse grey woolly hairs between the leaves. Leaves numerous, close, subdecussate, suberect, spreading, ovate, 4 lines long, obtuse, wrinkled, much keeled, pale-green, margined; margins translucent yellow-green; petioles short, stout, thick. Flowers few, solitary, sometimes in pairs on tips of branchlets; perianth very hairy, shaggy, 5 lines long; hairs white; lobes 4, oblong, subapiculate. Anthers oblong, excluded. Style longer than stamens; stigma simple.

Hab. Ruahine Mountain-range, slopes, east side; 1898: *Mr. A. Olsen.*

Obs. A species near *P. gnidia,* Forst., and also *P. subsimilis,* mihi (Trans. N.Z. Inst., vol xxviii., p. 609).

Genus 10. **Euphrasia,** Linn.

1. *E. pygmæa,* sp. nov. (*non* C. Koch).

Plant simple, minute, about ½ in. high, erect, glabrous; root 1½ in. long, slender, straight. Leaves few, generally 6, thickish, lowermost pair radical, opposite (seed leaves?), ovate, entire, obtuse; the next pair trifid or 3-lobed; the next cuneate-spathulate, limb 2 lines long, 7-lobed, the apical lobe large, rounded, the two lateral ones very small and distant, each 3-lobed; lobes, tips thickened, dark-green; limb pale, nearly white, tapering; petiole slender. Flower single, terminal, large for plant, sessile. Calyx 5-lobed; lobes deltoid, subacute, irregular in size, half as long as calyx. Corolla 3–3½ lines long; tube slender, long; lobes of limb large, rounded, 3-veined. Anthers glabrous, mucronate.

Hab. Ruahine Mountain-range, east side, secondary summits; 1898: *Mr. A. Olsen.*

Obs. I. I have lately received several 1-flowered specimens of this minute plant, all as described; and also—on a former occasion—some others, much larger, each bearing 2–3 flowers, terminal on short branchlets; which I take, without dissection, to be of the same species, and, if so, then the very minute 1-flowered specimens are young seedling plants.

II. Sir J. D. Hooker, in his "Handbook of the Flora of New Zealand," under "*E. antarctica*, Benth., a native of Tasmania, Fuegia, and South Chili" (which plant I also originally discovered on Ruahine Mountain-range in 1845), mentions having received from Sir James Hector several forms of *E. antarctica* collected on Mount Alta, one of them being "a most minute form, ½ in. high, with a single flower; altitude, 6,000 ft." I at first supposed that this little plant might prove to be of the same; but Bentham describes *E. antarctica* as being "glandular pubescent," with other marks of difference.

Order LXX. Cupuliferæ.

Genus 1. **Fagus**, Linn.

1. *F. truncata*, sp. nov.

A tree; branches (specimens 3 in.–4 in. long) slender; branchlets short; bark glabrous, dark purple-brown, irregularly ribbed and wrinkled. Leaves glabrous, rugulose, chartaceous, dull-green above, paler below, subrhomboid-oblong, ¾ in.–1 in. long, 6–7 lines wide, very obtuse, base slightly tapering, margined; margins thickened, white, dentate; teeth few, on upper half only, large, knobbed, caused by nerve being produced, generally 3–4 at truncate apex; midrib prominent beneath; nerves few (3–4-jugate), alternate, obsolete; veinlets closely anastomosing on lower surface, which is also finely dotted; petioles 2 lines long, narrow, slightly pubescent; leaf-buds narrow-ovoid, with 4 rows of scales, red-brown, shining. Flowers (male) on small branchlets, subcorymbose, solitary and 2–3 together on short peduncles, subsessile, pedicels small. Perianth very thin, glabrous and shining, slightly glutinous, broadly campanulate, margin shortly cut into 5 broad teeth or lobes, obtuse, rounded, 1-nerved; filaments short, not exserted; anthers long, linear, reddish-brown, deeply sulcated.

Hab. Ruahine Mountain-range, east side; October, 1898: *Mr. H. Hill.*

Obs. I. This plant is evidently allied to *F. fusca*, Hook. f., but differs from it in several characters—in its smaller leaves, which are also margined, their apices tri- or quadridentate, the teeth knobbed, and fewer nerves; its perianths very thin, glabrous and shining; and filaments not exserted. Sir J. D. Hooker, in his clear description of *Fagus fusca*,

says, "Branches clothed with minute pubescence, . . . nerves of leaves conspicuous (*pinninerviis*)" [in his faithful drawing represented 6-jugate and opposite]. "Flowers ternate, pedunculate, drooping; perianth turbinate, 5–6-toothed, downy as well as peduncle. Filaments slightly protruded; anthers oblong" ("Icones Plantarum," vol. vii., tab. 630).

II. I have received only two small specimens of this plant, both male, each possessing 12–14 leaves and 12–20 flowering perianths, apparently obtained as if casually gathered in passing; yet their difference is so great from *F. fusca, vera,* as described and ably drawn by Hooker, that I have considered it right to bring this plant to notice, even should it hereafter prove to be a variety only of *F. fusca.* A peculiarity in the leaves of these two specimens is that they are nearly all repeatedly bored through by some insects, twenty holes and upwards in some leaves.

Class II. MONOCOTYLEDONS.

Order I. Orchideæ.

Genus 12. **Pterostylis,** Brown.

1. *P. trifolia,* sp. nov.

Plant small, glabrous, 2½ in. high; 3-leaved at base; leaves close, equidistant, spreading, flat, sessile, broadly oblong, 1½ in. long, 1 in. broad, tips very obtuse-rounded, many-nerved longitudinally, with veins largely anastomosing between nerves. Scape 1 in. long, stout, erect; flower solitary. Perianth 1¼ in. diameter, sepals and petals nearly equal in length, narrow, sub 8 lines long, membranous and veined, not long-tailed; tongue narrow, thickish, dark-red, tip subacute, exserted; appendage large, membranous, veined, erect, curved, tip acute; column wings upper and lower corners largely produced, tips narrow-acute. Capsule very stout, obovoid, sub 1 in. long, 4 lines diameter; sutures ribbed, thick.

Hab. Ruahine Mountain-range, east side, near secondary summits; 1898: *Mr. A. Olsen.*

Obs. Only a single specimen received, and that with withered (though perfect) perianth, so could not afford to break it up for closer examination. A species very distinct from all other New Zealand ones known to me.

Art. XXVIII.—*The Fungus Flora of New Zealand.*

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Communicated by Sir J. Hector.

[*Read before the Wellington Philosophical Society, 20th September, 1898.*]

Plates XXII.-XXIV.

The last complete enumeration of New Zealand Fungi is contained in the "Handbook of the New Zealand Flora." Since the publication of this work, in 1864, many hundreds of Fungi have been received at Kew for identification, communicated by the Rev. William Colenso, F.R.S., F.L.S. Out of these, many proved to be undescribed species, while numerous others had not previously been recorded from New Zealand.

As an illustration of the numerous additions to the Flora, it may be mentioned that in the Handbook thirty-three species belonging to the *Agaricineæ*, or gill-bearing Agarics, are recorded, whereas at the present day no fewer than one hundred and thirty-two species are known. An equal increase in numbers is also true of the other groups of Fungi.

Under the circumstances, it is considered that the study of mycology in New Zealand would be facilitated by indicating what has already been done, and in giving diagnoses of all indigenous species. Apart from the purely scientific side of the subject, it is absolutely essential, from an economic standpoint, that a sound knowledge of the numerous destructive parasitic species should be possessed by those whose duty it is to superintend and advise on the best means of protecting the vegetable products of the country from their attacks.

The Nature of Fungi.

The amount of evidence possessed at the present day favours the idea that the Fungi have descended in a direct line from the Algæ, and, by gradual differentiation and adaptation to a life on dry land, have at some distance from the point of departure from the parent stock gradually acquired a set of characteristics which collectively give an individuality to the group. On the other hand, the Fungi are strictly a terminal group—in other words, there are no indications of a departure, either morphologically or physiologically, from the Fungi that suggest the starting-point of a new order of things. The mutualism between Fungi and Algæ that has resulted in the production of the group of plants collectively known as

Lichenes cannot be considered in the sense of being a branch from the fungal stock, and must have come into existence long after the complete differentiation of the Fungi was effected, because the fungal element in lichens corresponds to the ascigerous Fungi, *Sphæriaceæ* and *Discomycetes*, which do not belong by any means to the earliest differentiated groups of Fungi.

The bulk of Fungi with which people generally are most familiar are truly terrestrial, belonging to sections that have ages ago forsaken the aquatic home of their ancestors; nevertheless, numerous truly aquatic Fungi do still exist, and such, as would be expected, are morphologically most in touch with the Algæ. As an example of such algal-like Fungi, as they are termed by Brefeld, may be mentioned the *Saprolegniæ*, which morphologically, and in the sexual mode of reproduction, closely agree with such Algæ as *Vaucheria*. These primitive Fungi also agree with some of the Algæ in possessing a unisexual, as well as a sexual, mode of reproduction, and one feature that has been constantly kept in view in the evolution of the Fungi, and to which they owe to a great extent their individuality as a distinct group of organisms at the present day, is the gradual suppression of the sexual mode of reproduction, and the proportional elaboration of the asexual method, until finally, in the most highly evolved and at the same time the most modern section of the Fungi, the *Basidiomycetes*, the sexual mode of reproduction has completely disappeared, and so dissimilar are the components of this group, including the numerous forms popularly known as mushrooms, toadstools, puffballs, &c., to the Algæ that, but for the connecting-links still existing in an almost unbroken chain, their origin would certainly never have been suggested.

The only observable difference between the Algæ and those Fungi most closely related consists in the suppression of chlorophyll in the latter—a condition which necessitated a change in the mode of life: the Fungi, being unable to assimilate inorganic food, became parasites, obtaining their food from living organisms—plants or animals; or saprophytes, obtaining their food from dead and decaying organic matter.

The early groups of Fungi include numerous parasitic species, whereas in the later, or more modern, groups saprophytic species are most abundant. Numerous species can only live, through their entire life-cycle, as parasites, and are termed "obligate parasites," as the members of the *Uredineæ*, commonly known as "rusts," the destructive parasites of cereals, &c.; others possess the power of living as saprophytes and parasites respectively at different periods of their existence, and are called "facultative parasites."

The supposed rapidity with which Fungi spring up, mature their spores or reproductive bodies, and disappear has become proverbial—at least in the Northern Hemisphere. Nevertheless, such an idea is a mistake. The part popularly considered as constituting the entire fungus—that is, the part appearing outside the matrix on which the fungus is growing—is only a part of the organism, corresponding functionally to the fruit of a flowering-plant, and is solely concerned with the continuation of the species; whereas the vegetative portion of the fungus—the portion upon which the continuation of the individual depends—is always buried in the substance upon which the fungus is growing. If we take as an example any ordinary mushroom or toadstool, we find a weft of slender threads forming the vegetative portion, known as mycelium, or spawn, permeating the matrix or substance on which the fungus is growing. On this mycelium the sporophores, or spore-producing portions, first appear as minute white lumps, not a millimetre in diameter. These continue to increase in size, and become differentiated into pileus, or cap, stem, gills, &c., while yet underground; and finally, when the structure is completely elaborated, it pushes up above the surface of the matrix, for the purpose of having its spores dispersed by wind or other agents.

In the majority of Fungi the very minute spores are dispersed by currents of air; in many of the subterranean Fungi animals, especially rodents, scratch up the Fungi, which they eat, and probably the spores pass through the alimentary canal uninjured, and are thus dispersed. Finally, in one group of Fungi—the *Phalloideæ*—brilliant colours, combined with a powerful smell, attract insects, which readily feed on a sweet, semi-liquid substance, containing the minute spores in suspension, which are thus disseminated. It is interesting to note that colour and smell, the agents used by many flowering-plants for the purpose of advertising their whereabouts to insects, which, in return for a supply of nectar, unconsciously effect cross-fertilisation, should be utilised by some Fungi for the purpose of securing spore dissemination.

As previously stated, many Fungi have two or more different modes of reproduction. This is especially observable in the instance of destructive parasites, or, in other words, this arrangement enables certain species to act as wide-spreading and injurious pests to cultivated crops. The process is as follows: In species parasitic on annual plants, as cereals, the fungus continues to produce, in rapid succession, innumerable asexually formed conidia, or reproductive bodies, which possess the power of germinating the moment they are mature. These conidia are washed by rain or carried by wind on to the surface of healthy leaves, where they germinate at once, enter

the tissues, and within a very short time form a new centre of disease, producing conidia, which in turn are dispersed and extend the disease.

From the above account it may be seen how quickly a disease can spread when it has once gained a foothold in places where the host-plant is in considerable numbers and close together, as in a field of corn, in an orchard, forest, &c. These conidia are known as summer-spores, their special function being to enable the fungus to extend its geographical area.

Towards the end of the season, when the vitality of the host-plant is on the wane, the same mycelium which produced conidia, or summer-spores, now gives origin to a different form of fruit, known as resting-spores or winter-spores. These spores remain in a passive or resting state until the following season, and germinate at the time when the host-plant is pushing into active life. The function of the resting-spore condition is to secure the continuation of the species, by tiding it over that portion of the year when the host-plant is not in active growth.

In addition to the production of resting-spores, the mycelium of many species of Fungi becomes concentrated into a number of compact masses or nodules, called "sclerotia," usually of a black colour externally. These sclerotia, which vary in size in different species from that of a pin's head to a cricket ball, also remain in a quiescent state during the winter, in the tissues of the leaves or stem where they are formed, or in the ground, and in the following spring produce reproductive organs, which infect the young leaves of the host-plant, and commence anew the cycle of development.

From the above account it will have been gathered that resting-spores, or sclerotia, give origin to the disease in the first instance by inoculating the host-plant, the spread of the pest being afterwards secured by the rapid production of summer-spores. Although the leaves or stems bearing resting-spores or sclerotia may completely decay during the winter, the reproductive parts of the fungus do not perish, but remain lying on the ground until the host again makes its appearance, and then act as already described. The resting-spores on the straw of cereals do not fall away readily. The corn may be harvested, the straw used for fodder, pass on to the manure-heap, be returned to the land as manure, and yet the resting-spores may be found attached to fragments of the decaying straw, and quite capable of germination. Finally, resting-spores and sclerotia often possess the power of remaining in a dormant condition for several years, thus extending the means for continuing the struggle for the survival of the fittest, often much to the disadvantage of the farmer and horticulturist.

It has been estimated that damage to the extent of fifty millions of pounds annually is caused by parasitic Fungi alone to cultivated crops, and it is also equally certain that the greater part of this damage could be prevented if proper precaution was exercised. This precaution can only be carried into effect when a sufficient number of experts are available for the purpose of imparting information directly to those most immediately concerned.

Classification.

There are at the present day about forty-five thousand accepted species of Fungi. These numbers are in future much more likely to be reduced than increased, as many forms accepted at the present day as entities will certainly prove to be simply forms in the life-cycle of other species. Nevertheless, we have an enormous assemblage of undoubted species, and the grouping of these into natural families has engaged the attention of several of our most able mycologists. Notwithstanding the brilliant discoveries made during the last half-century, important fundamentals are far from being satisfactorily settled. For example, as regards the important point relating to sexual reproduction, the three observers who have paid most attention to the subject—De Bary, Brefeld, and Dangeard—have arrived at conclusions diametrically opposed to each other, and, as all cannot be right, the question is still open. Under the circumstances, it is considered advisable, in a purely systematic work, to adopt a classification which enables the student to determine a species with the greatest possible facility; its peculiarities—morphological, physiological, &c.—can afterwards be obtained from special works devoted to that branch of the subject, experience having taught that all attempts to weave such details into a work dealing entirely with the discrimination of species has resulted in failure.

The following works give the result of biological research into the life-history of the Fungi:—

"Vergleichende Morphologie der Pilze" (Dr. F. von Tavel); 90 figs. Jena, 1892.—This contains a condensed account of the whole of Brefeld's investigations on the life-history of the Fungi.

"Introduction to the Study of Fungi" (Dr. M. C. Cooke); numerous figs. 1895. Black and Co. 18s.—Contains a general sweeping-up of all recent works on Fungi; especially valuable for geographical distribution and broad features of the various groups.

"Plant Life" (G. Massee); figs. 1890. Methuen and Co. 2s. 6d.—An introduction to the study of cryptogamic botany.

BASIDIOMYCETES.

Naked spores borne on basidia; basidia closely packed side by side to form a continuous spore-bearing surface, or hymenium, which may be exposed from the first, or concealed until the spores are mature. Sexual reproduction absent.

The *Basidiomycetes* are divided into two primary groups, as follows:—

1. HYMENOMYCETES.

Hymenium exposed from the first, or at an early stage of development, and before the spores are mature.

2. GASTROMYCETES.

Hymenium concealed within a continuous membrane or peridium until the spores are mature.

HYMENOMYCETES.

The *Hymenomycetes* are divided into the following families:—

I. Agaricineæ.

Hymenium covering radiating gills or lamellæ.

II. Polyporeæ.

Hymenium lining the walls of pores or tubes.

III. Hydneæ.

Hymenium covering slender spines, teeth, or granular warts.

IV. Thelephoreæ.

Hymenium covering a smooth or very slightly irregular surface.

V. Clavarieæ.

Hymenium spread over club-shaped or much-branched, erect sporophores.

VI. Tremellineæ.

Sporophore entirely gelatinous, hymenium covering its entire surface.

AGARICINEÆ.

The most highly differentiated of the *Hymenomycetes*, characterized by having the hymenium spread over thin, radiating gills or lamellæ. The general structure consists of the pileus, or cap (Plate XXII., fig. 6*d*), bearing the gills on its under-surface, and supported by a stem. In the most highly evolved forms the entire fungus is enclosed when quite young in a continuous sheath or universal veil (Plate XXII., figs. 4, 5), which becomes ruptured during growth, the upper

portion being often carried up by the pileus and torn into patches or warts as the pileus expands (Plate XXII., fig. 6*b*). The lower portion of the universal veil remains as a sheath round the base of the stem, and is known as a volva (Plate XXII., fig. 6*a*). A partial veil is present in some species, which, in the young stage of the fungus, forms a membrane extending from the upper part of the stem to the margin of the pileus (Plate XXII., fig. 12*a*), thus concealing the gills. As the pileus expands the veil separates from the margin or edge of the pileus, shrinks up, and forms a ring or annulus round the stem (Plate XXII., fig. 6*c*). In some species both primary and secondary veils are present; in some forms one or other may be absent, and in the majority of species both are absent from the first.

The pileus is regular when its form is symmetrical, and the gills radiate equally on all sides from its centre; excentric when the gills radiate from an excentric point (Plate XXII., fig. 7); dimidiate when the stem is absent or nearly so, and the pileus is attached laterally, and projects horizontally from its point of attachment (Plate XXII., fig. 10); sessile when the stem is entirely absent; resupinate when the pileus is attached to the substance on which it is growing, and the gills necessarily point upward, as in primitive types (Plate XXII., fig. 10); umbonate when there is a rather pointed projection or boss in the centre or apex of the pileus (Plate XXII., fig. 8*a*); gibbous when the boss is broader and blunter than in the umbonate type (Plate XXII., fig. 9*a*); umbilicate when there is a small dimple at the apex of the pileus (Plate XXII., fig. 2*a*); infundibuliform when the pileus is depressed like a funnel (Plate XXII, fig. 1*a*); striate when evenly and slightly fluted for some distance up from the margin (Plate XXIV., fig. 7); sulcate when the ridges are stronger than in the striate type. Many terms, such as "convex," "campanulate," "warted," "glabrous," "viscid," "scaly," &c., are self-explanatory.

The genera of the *Agaricineæ* are founded to a great extent on the mode of arrangement and structure of the gills. When the gills are grown to the stem, down which they extend for some distance, thinning out to a narrow point, they are said to be decurrent (this is the most primitive type) (Plate XXII., fig. 1*b*); adnate when the gills are attached to the stem by their entire breadth, but do not run down the stem (Plate XXII., fig. 2*b*); adnexed when the gills are slightly rounded off where they touch the stem, so that they only grow to the stem by about half their entire width (Plate XXII., fig. 8*b*); sinuate when the gill is cut out in a curved manner close to the stem, to which it grows only by a small portion of its width (Plate XXII., fig. 9*b*) (sinuate differs from

CORRIGENDA

In Mr. Massee's Article XXVIII., on "The Fungus Flora of New Zealand."

Page 289, line 6. *Insert a comma after* thickened.
Page 289, line 19. *Insert a comma after* fibrous.
Page 291, line 14 from bottom. *For* fimetarius *read* fumitarius.
Page 292, line 8. *For* 0·7 *read* 12.
Page 293, line 6 from bottom. *Delete* primrose.
Page 301, line 2. *For* purpureo-nitens *read* sapinea.
Page 301, line 5 from bottom. *Insert* vol. ix., p. 115.
Page 307, line 16 from bottom. *For* crinacea *read* erinacea.
Page 309, line 17. *For* Eleuch *read* Elench.
Page 349, line 3. *For* plant *read* pileus.

NOTE.—A proof was sent to the author in England, and these corrections were supplied by him, but were received too late for insertion.

[To face p. 289

adnate in the presence of an evident notch where the gill joins the stem); free when the gills are completely rounded off behind, so that they do not reach the stem (Plate XXII., fig. 11). Attention must be paid to the edge or margin of the gill, as to whether it is entire, minutely toothed or serrated, thin or acute, thickened or split. If a very thin section of a gill is examined under the microscope it will present something of the appearance shown in Plate XXIV., fig. 3, where *a* is the trama, or central portion, which is a continuation of the hyphæ forming the flesh of the pileus; branches of the hyphæ of the trama give origin to the basidia (*b*), also to numerous other bodies not bearing spores, and termed "paraphyses" (*c*). In addition to these two structures, basidia and paraphyses, which are always present in the hymenium, certain other bodies, of larger size and projecting above the basidia, are present in certain species, and are called "cystidia" (*d*).

The special points connected with the stem are position—as to whether central or excentric, solid or hollow, presence or absence of ring or volva, fibrous or cartilaginous and polished externally. Finally, the following features should be noted as essentials in the discrimination of species: Dry or viscid, smooth, scaly, or fibrous texture of pileus or stem; presence or absence of smell or taste, the latter, when present, sometimes very pleasant, at others intensely pungent, especially in the genus *Lactarius*, which is characterized by the presence of latex, or milk, which escapes from the broken tissues as a thick, white, or variously coloured liquid, in many instances of a very pungent nature. so that a minute portion on the tongue causes a burning sensation, which lasts for some little time.

In the general evolution of the *Agaricineæ* the species with decurrent gills are the lowest and most ancient type; next come species with adnate gills, followed by those having adnexed gills; while, finally, the species with free gills are last to appear in the scheme of development, and are most perfectly adapted for surviving in the general struggle, as proved by superiority in numbers and wide geographical range. In addition to the above structural sequence of development, the *Agaricineæ* further evolved a sequence of five groups depending on the colour of the spores. The oldest in time, and structurally the most primitive, have black spores; next follows a series with purple-brown spores, followed by a third series having rust-coloured or ochraceous spores; the fourth series has salmon-coloured or pink spores, while the last and newest in order of time has white spores. In each of these spore-colour groups the original sequence of the position of gills is repeated—that is, we have genera with free gills, for instance, in each of the colour-groups, and so on. The signi-

ficance of this sequence of development cannot be discussed here. Those interested in the subject will find an explanation in the Journal of the Quekett Microscopical Club (ser. 2, vol. 7; April, 1898).

The spores of all fungi are colourless when young, the characteristic colour they eventually possess being developed in the wall of the spore just before maturity. When the colours of spores are spoken of, the colour of the mass of spores as seen by the naked eye when deposited on paper is intended. To obtain spores in this way, cut off the stalk of an agaric close to the pileus, place the pileus, gills downwards, on paper, and after a few hours a copious deposit of spores will take place. If the pale gills suggest white spores use black paper, if dark spores use white paper.

I. Melanosporæ.

Spores black; gills dark-coloured at maturity, speckled with the black spores. No tinge of purple present.

II. Porphyrosporæ.

Spores purplish-black; gills blackish or brown, with a purple tinge at maturity.

III. Ochrosporæ.

Spores ochraceous, brown, or bright rust-colour; gills at maturity ochraceous, brownish, or rusty orange. No tinge of purple present.

IV. Rhodosporæ.

Spores salmon-colour or pinkish; gills salmon-colour or rosy at maturity.

V. Leucosporæ.

Spores white; gills in most species white at maturity. In some species the gills are yellow or grey, but the permanently white spores determine the group.

Melanosporæ.

Analysis of the Genera.

* *Gills deliquescing into a black fluid at maturity.*

1. Coprinus.

** *Gills not deliquescing, pileus not striate.*

2. Anellaria. Stem with a ring.
3. Panæolus. Stem without a ring.

*** *Gills not deliquescing, pileus striate.*

4. Psathyrella.

1. **Coprinus**, Pers.

Pileus regular, thin, often striate; gills free or variously attached, never decurrent, whitish at first, becoming black with the spores, deliquescing at maturity; stem central, sometimes with a volva and ring; spores black.

Coprinus, Persoon, Syn. Fung., p. 395 (as a section of *Agaricus*).

Distinguished from allies by the deliquescence of the gills at maturity, which become converted into a dripping mass of inky-black fluid. The pileus also disappears very quickly. Growing on dung, or rich soil, sometimes round stumps, posts, &c.; usually clustered.

1. *Coprinus comatus*, Fries, Epicr., p. 242; Massee, Brit. Fung.-Flora, i., p. 305, fig. 1, p. 303; Austr. Fung., p. 68; Sacc., Syll. v., no. 4375.

Pileus cylindrical, then campanulate, finally expanding and deliquescing, at first even; during growth and expansion the cuticle becomes torn into broad adpressed or loose scattered scales, cream-colour, interstices white and silky, 7–12 cm. high; flesh white, thin except at the apex; gills almost free, about 1 cm. broad, crowded, white, then pinkish, at length black; spores almost black, elliptical, 13–18 × 7–8 μ; stem 18–16 cm. high, 1–2 cm. thick, subequal, white, even, hollow, more or less bulbous, bulb solid; ring movable on the stem, soon disappearing.

Amongst grass, in pastures, waste places near towns, &c.; not on dung. Northern Island, New Zealand. Australia, Europe, United States.

A large, fine species, growing in troops, readily distinguished by its large size and cylindrical form of the whitish shaggy pileus. One of the best and safest of edible fungi.

2. *Coprinus fimetarius*, Fries, Epicr., p. 245; Hdbk. N.Z. Flora, p. 604; Austr. Fung., p. 68; Sacc., Syll. v., no. 4404.

Pileus clavate, then conico-expanded, soon split and upturned, greyish, apex tinged with brown, covered at first with white floccose scales, then naked and coarsely grooved, 2·5–5 cm. across, disc even, flesh thin; gills free, lanceolate, narrow, wavy, black; spores 12–14 × 7–8 μ; cystidia large, numerous; stem 10–15 cm. long, white, apex downy, squamulose below, hollow except the thickened base.

On manure-heaps, dung, &c. Canterbury Province, Middle Island, New Zealand. Australia, Europe, Siberia, United States.

Solitary, or usually clustered, soon splitting, curling up

and deliquescing into a black, dripping liquid, leaving the stems standing.

3. *Coprinus colensoi*, Berk., Flora N.Z. ii., p. 175; Hdbk. N.Z. Flora, p. 604; Sacc., Syll. v., no.

Pileus cylindrical, obtuse, then campanulate, very thin, covered with snow-white scurfy meal, below the meal greyish and slightly striate, $\frac{1}{2}$–$\frac{3}{4}$ cm. high; gills narrow, black; spores blackish-brown, elliptic-oblong, 0·7 μ long; stem 1·5 4 cm. long, slender, tomentose, white.

On dung; subfasciculate. Northern Island, New Zealand.

A pretty little endemic species, allied to *Coprinus niveus*, but smaller, and the pileus not so cottony in its covering or veil.

2. **Anellaria**, Karsten.

Pileus slightly fleshy, regular, smooth and even; gills adnexed, slate-grey, becoming variegated with the black spores; stem central, ring present when young, either persistent or forming a zone round the stem; spores black.

Anellaria, Karsten, Hattsvamp., i., p. xxv.

Separated from the genus *Panæolus* on account of the presence of a more or less definite ring on the stem. Growing on dung or richly manured ground.

4. *Anellaria separata*, Karsten, Hattsv., i., p. 517; Sacc., Syll. v., no. 4560; Brit. Fung.-Flora, i., p. 330, figs. 2–5, p. 330. *Agaricus separatus*, Linn., Suec., no. 1220.

Pileus ovate, then campanulate, very obtuse, not expanding, viscid, even, ochraceous, then whitish, shining, often somewhat rugulose, 2–4 cm. high and wide; flesh thin, white; gills adnexed, ascending, thin, crowded, broad, greyish-black, margin paler; spores broadly elliptic-fusiform, black, opaque, $10 \times 7\ \mu$; stem 6–14 cm. long, straight, base somewhat clavate, narrowed upwards, whitish, shining, apex slightly striate; ring persistent, distant (from the apex).

On dung. New Zealand. South Africa, Europe, Argentine Republic.

Variable in size, sometimes quite small, but readily distinguished by the pale, ochraceous, viscid pileus, which becomes whitish and wrinkled when old, and the long, straight stem bearing a persistent, almost median, ring.

5. *Anellaria fimiputris*, Karsten, Hattsv., i., p. 518; Sacc., Syll. v., no. 4561; Brit. Fung.-Flora, i., p. 331. *Agaricus (Panæolus) fimiputris*, Austr. Fung., p. 66.

Pileus submembranaceous, conical, then expanded, with an indication of a broad umbo, even, viscid, smoky-grey,

pale dingy ochraceous when dry, 2·5–5 cm. broad; gills adnate, 4–6 mm. broad, greyish-black, margin the same colour; spores elliptical, apiculate, 9–10 × 6 μ; stem 6–12 cm. high, about 4 mm. thick, often rather flexuous, equal, smooth, pallid, hollow; ring imperfect, usually only indicated by a pale zone round the stem above the middle.

On dung, &c. New Zealand. Australia, Europe, United States.

Solitary, gregarious, or clustered. Differs from *Anellaria separata* in colour, and in the very imperfect ring, and in this last character connects the genera *Anellaria* and *Panæolus*. Differs from *Coprinus* in the gills not being deliquescent.

3. **Panæolus,** Fries.

Pileus regular, rather thin, never striate, margin extending beyond the end of the gills; gills adnexed, grey, then mottled with the black spores; stem central, without ring or volva; spores black.

Panæolus, Fries, Epicr., p. 234 (as a subgenus of *Agaricus*).

Distinguished amongst the *Melanosporæ* by the even, non-striate pileus, and the absence of ring and volva on the stem. In *Psathyrella* the pileus is striate, and the gills black, not mottled; in *Anellaria* there is a ring on the stem, whereas in *Coprinus* the gills deliquesce into a black, inky liquid at maturity. Growing on dung or richly manured ground.

6. *Panæolus papilionaceus*, Fries, Epicr., p. 136; Austr. Fung., p. 67; Sacc., Syll. v., no. 4547.

Pileus slightly fleshy, almost exactly hemispherical, obtuse, even, glabrous, the cuticle often becoming broken up into minute squamules when dry, pale-grey, with a tinge of rufous, especially at the disc, 1·5–2·5 cm. across; gills broadly adnate, very broad, up to 6 mm., plane, at length blackish with the spores; spores elliptical, 11–12 × 7 μ; stem 6–10 cm. long, 4 mm. thick, equal, smooth, whitish, apex powdered with white meal, hollow.

On dung, manured ground, &c. New Zealand. Australia, Ceylon, Europe, Siberia, Central Africa, United States.

Distinguished from some closely allied species—not yet met with in New Zealand—by the obtuse hemispherical pileus, broadly adnate broad gills; and whitish stem, powdered with white primrose meal at the apex.

4. **Psathyrella,** Fries.

Pileus regular, thin, striate, margin straight and pressed to the stem when young, not extending beyond the end of the gills; gills free or adnexed, not deliquescent; stem central; spores black.

Psathyrella, Fries, Epicr., p. 237 (as a subgenus of *Agaricus*).

Structurally most closely allied to *Psathyra*, a genus included in the *Porphyrosporæ*, but in the latter the purplish-brown colour of the spores is distinctive. Growing on the ground.

7. *Psathyrella disseminata*, Pers., Syn., p. 403 (1801); Cke., Hdbk. Austr. Fung., p. 68; Sacc., Syll. v., no. 4597.

Densely tufted. Pileus about 1 cm. across, membranaceous, ovate-campanulate, at first scurfy then naked, coarsely striate, margin entire, yellowish-tan, then grey; gills adnate, narrow, whitish, then grey, finally blackish; spores elliptical, 6–10 × 3–5 μ; stem 2–4 cm. long, very slender, almost equal, rather curved, mealy then smooth, fragile, hollow.

About trunks and stumps, and on the ground. New Zealand. Victoria, Queensland, Western Australia, Tasmania, Ceylon, South Africa, Europe, Siberia.

Forming large, dense tufts; very slender and fragile, soon flaccid, but not deliquescent.

PORPHYROSPORÆ.

ANALYSIS OF THE GENERA.

* *Gills attached to the stem.*

† Ring imperfect or absent.

5. HYPHOLOMA.

†† Ring perfect on the stem

6. STROPHARIA.

** *Gills free from the stem.*

7. AGARICUS.

5. **Hypholoma**, Fries.

Pileus regular, fleshy, margin incurved when young; gills adnate or adnexed and sinuate; stem central, veil cobweb-like, not forming a distinct ring, after rupture attached in fragments to margin of pileus; spores purple-brown.

Hypholoma, Fries, Syst. Myc., i., p. 287 (as a subgenus of *Agaricus*).

Mostly tufted and growing on wood, buried roots, &c. Distinguished from *Stropharia* by the absence of an interwoven complete ring on the stem. When a trace of a ring is present it is in the form of delicate fibres, and very scanty.

Hypholoma agrees in structure with *Hebeloma*, *Entoloma*, and *Tricholoma*. On wood, or clustered on or around stumps; often clustered.

8. *Hypholoma appendiculatum*, Bull., Champ. France, pl. 392; Flora N.Z., ii., p. 175; Hdbk. N.Z. Flora, p. 604; Sacc., Syll. v., No. 4214.

Pileus ovate, then widely campanulate, glabrous, bay-brown when young and moist, becoming white with an ochraceous tinge, wrinkled and rather atomate when dry, 4–7 cm. across, the remains of the veil often forming an irregular fringe to the margin of the pileus when young; flesh thin; gills adnexed, crowded, dry, rather narrow, whitish, then pinkish, at length brown; spores elliptical, $5 \times 2{\cdot}5\ \mu$; stem 4–7 cm. long, 5–6 mm. thick, equal, glabrous, apex mealy, white, hollow.

In tufts, on trunks, stumps, &c. Northern Island, New Zealand. Europe, South America.

A closely allied species, *H. candolleanus*, not yet recorded for New Zealand, is distinguished by having the gills pale-violet at first.

9. *Hypholoma fasciculare*, Huds., Flora Angl., p. 615; Flora N.Z., ii., p. 175; Hdbk. N.Z. Flora, p. 603; Austr. Fung., p. 62; Sacc., Syll. v., no. 4178.

Densely clustered, bitter; pileus bluntly campanulate, then expanded and somewhat umbonate, glabrous, even, tawny, margin yellowish, 2·5–5 cm. across; flesh thin, yellow; gills adnate, crowded, narrow, pale-yellow, then greenish, clouded with the dark spores, inclined to deliquesce at maturity; spores elliptical, $7 \times 4\ \mu$; stem 6–10 cm. long, 4–6 mm. thick, yellow, fibrillose, hollow, often more or less curved.

On old stumps, &c. Northern Island, New Zealand. Australia, Tasmania, Europe, Ceylon, Natal.

Distinguished by the densely crowded habit, bitter taste, and greenish gills. Poisonous. *Flammula inopoda* somewhat resembles the present species, but differs in the long rooting base of the stem and the absence of a bitter taste.

10. *Hypholoma stuppeum*, Berk., N.Z. Flora, ii., p. 175; Hdbk. N.Z. Flora, p. 604 (as *Agaricus (Hypholoma) stuppeus*); Sacc., Syll. v., no. 4195.

Pileus convex, then expanding until almost plane, rather fleshy, tawny or brownish, shaggy, especially towards the margin, with spreading, crowded, pointed scales, each consisting of a fascicle of hyphæ, 4–6 cm. broad; gills adnexed, crowded, thin, umber-brown; spores obliquely pip-shaped, brownish, $7 \times 4\ \mu$; stem 2–3 cm. long, nearly 1 cm. thick, fibrillose, becoming smooth, thickened at the base, and attached to the soil by a copious development of mycelium.

On the ground. New Zealand.

Allied to the European species *Hypholoma velutinus*, *H. lacrymabundus*, and *H. pyrotrichus*, but differing from all in the tomentum of the pileus being in the form of shaggy, fibrous scales. Type specimen examined.

6. **Stropharia,** Fries.

Pileus regular, fleshy, often covered with a viscid pellicle; gills adnate or adnexed, becoming purplish-brown at maturity; stem present, round which the veil forms a distinct ring; spore purplish-brown.

Stropharia, Fries, Monogr., i., p. 408 (as a subgenus of *Agaricus*).

Distinguished amongst the *Porphyrosporæ* by the presence of a distinct ring on the stem in conjunction with attached gills. *Stropharia* corresponds with *Pholiota* and *Armillaria.* Growing on dung or rich ground.

11. *Stropharia semiglobata,* Fries, Syst. Myc., i., p. 291; Hdbk. N.Z. Flora, p. 603; Austr. Fung., p. 62; Massee, Brit. Fung.-Flora, i., p. 404, fig. 17, p. 351; Sacc., Syll. v., no. 4151.

Pileus persistently hemispherical, obtuse, even, viscid, pale-yellow, 1·5–3 cm. across; flesh thin, white; gills broadly adnate, up to 1 cm. broad in larger specimens, margin straight, greyish, clouded with the dark spores, rather close together; spores 12 × 6 μ; stem 6–12 cm. high, 3–5 mm. thick, equal, glabrous, viscid, yellowish, hollow, ring imperfect, inferior, soon stained with the dark spores.

On dung. Middle Island, New Zealand. Australia, Tasmania, South Africa, Europe, Siberia, United States.

Distinguished by the hemispherical viscid pileus and broad gills. In very large vigorous specimens the pileus sometimes becomes plano-convex. Poisonous.

7. **Agaricus,** L. (emended).

Pileus regular, fleshy; gills free from the stem, whitish at first, finally dark-umber; stem central, furnished with a ring; spores brownish-purple.

Agaricus, L., Syst. Nat. (1735) (in part).

Distinguished by the free gills and ring on the stem. The *Agaricus* of Linnæus, as interpreted by Fries, was divided into several subgenera by the last-named author, and the original name *Agaricus* has been retained for those species included in the subgenus *Psalliota* of Fries. *Agaricus* as here understood is morphologically similar to *Lepiota* in the *Leucosporæ.* All grow on the ground; often in open pastures.

12. *Agaricus arvensis,* Schæffer, Icon., t. 310, 311; Flora N.Z., ii, p. 174; Hdbk. N.Z. Flora, p. 603; Austr. Fung., p. 60; Sacc., Syll. v., no. 4039.

Pileus bluntly ovate, then expanded and slightly convex, slightly mealy at first, white and silky, becoming stained pale-

yellow when bruised, 10–25 cm. across; flesh thick at the disc, becoming thin towards the margin, yellowish when cut; gills free, broadest in front, rather crowded, whitish, then reddish-brown; spores elliptical, 6 × 4 μ, stem stout, 7–12 cm. high, rather swollen at the base, almost cylindrical above, white, smooth, even, soft in the centre and filled with loose fibres; ring pendulous, double, the outer membrane more or less torn.

In pastures, &c., often growing in rings. Northern Island, New Zealand. Australia, Tasmania, South Africa, Ceylon, Europe.

Closely allied to *Agaricus campestris*, but known by the pileus becoming yellow when bruised, and the flesh of pileus and stem not changing to brown when cut. Smell strong and pleasant. Edible; preferred by many to the mushroom (*A. campestris*). In large specimens the pileus is sometimes cracked or scaly, and brownish when old.

13. *Agaricus campestris*, Linn., Suec., no. 1205; Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 603; Austr. Fung., p. 60; Sacc., Syll. v., no. 4053.

Pileus globose, then expanding until plano-convex, dry, silky, floccose, or broken up into squamules, whitish, sometimes tinged brown, 6–15 cm. broad; flesh thick at the disc, margin thinner, becoming reddish-brown when cut, as does also that of the stem; gills free, but close to the stem, pale-pink, then flesh-colour, finally blackish-brown, inclined to deliquesce at maturity; spores 7–9 × 6 μ; stem 7–12 cm. long, stout, subcylindrical, white, stuffed; ring median on the stem, persistent, more or less torn.

In pastures, &c. Northern Island, New Zealand. A cosmopolitan species.

Edible. Known as the "mushroom" in Britain. (See note under *A. arvensis*).

14. *Agaricus campigenus*, Berk., Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 603; Sacc., Syll. v., no. 4102.

Pileus campanulate, rather fleshy, very obtuse, silky, with a few scattered scales, assuming a reddish hue when dry, about 2·5 cm. high; gills rather narrow, narrowed behind, adnexed or slightly adnate; spores pale red-brown, obliquely obovate; stem 4 cm. high, about 4 mm. thick, incrassated at the base, slightly furfuraceous, with a broadish ring near the top.

On the ground, among grass. New Zealand.

This has much the habit of a *Lepiota*, but the gills are adnexed and the spores pale but decidedly coloured (Berk.).

The type specimens are destroyed by insects, hence nothing can be added to the above information. If the gills are adnexed the plant cannot belong to *Agaricus* (the old *Psalliota*).

OCHROSPORÆ.

ANALYSIS OF THE GENERA.

* *Stem excentric, or absent.*

8. CREPIDOTUS.

** *Stem central, without a ring.*

† Gills decurrent.

9. TUBARIA. Gills triangular; veil absent.
10. FLAMMULA. Gills not triangular; veil present.

†† Gills adnate or adnexed.

11. GALERA. Margin of pileus not incurved when young.
12. NAUCORIA. Margin of pileus incurved when young; gills not sinuate.
13. HEBELOMA. Margin of pileus incurved when young; gills sinuate.

*** *Stem central, with a ring.*

14. PHOLIOTA.

8. **Crepidotus**, Fries.

Pileus excentric, often resupinate or attached laterally; gills more or less decurrent; stem excentric, lateral, or absent; spores rust-colour.

Crepidotus, Fries, Syst. Myc., i., p. 272 (as a subgenus of *Agaricus*).

Distinguished by the resupinate and sessile or excentrically stipitate pileus; many of the species are minute. *Claudopus* is the analogous genus in the *Rhodosporæ*, and *Pleurotus* in the *Leucosporæ*. Growing on dead wood.

15. *Crepidotus mollis*, Schæffer, t. 213; Austr. Fung., p. 58; Sacc., Syll. v., no. 3600.

Imbricated, horizontal; pileus obovate or reniform, flaccid, sessile, or with the posterior of the pileus narrowed into a strigose stem-like base, soft and flaccid, glabrous, pale dingy tan, then greyish, 3–7 cm. across; flesh rather gelatinous, soft; gills radiating from the point of attachment of the pileus, more or less decurrent, crowded, about 3 mm. broad, whitish, then watery cinnamon; spores elliptical, dingy brown, 8–9 × 6 μ.

On rotten trunks and stumps. Dannevirke, New Zealand. Australia, Borneo, Europe, United States.

When large the margin of the pileus is frequently more or less lobed or uneven. Remarkable for the soft consistency of the entire fungus.

9. **Tubaria,** W. G. Smith.

Pileus regular, thin; gills more or less decurrent, broadest behind, or near the stem, hence somewhat triangular; stem central, hollow; spores rusty.

Tubaria, W. G. Smith, Journ. Bot., 1870.

The species are small and delicate; known amongst the *Ochrosporæ* by the more or less decurrent, triangular gills. Corresponds in structure to *Eccilia* in the *Rhodosporæ*, and *Omphalia* in the *Leucosporæ*. Growing on the ground.

16. *Tubaria furfuracea*, Pers., Syn., p. 454; Austr. Fung., p. 57; Sacc., Syll. v., no. 3584.

Pileus rather fleshy at the disc, convex, then plane, margin spreading, at length depressed or umbilicate, yellowish-cinnamon, paler and hoary or silky-squamulose, due to the breaking-up of the cuticle when dry, 1·5–5 cm. across; gills adnato-decurrent, rather distant, about 3 mm. broad, cinnamon; spores elliptical, $10 \times 6\,\mu$; stem 2–5 cm. long, 2–4 mm. thick, rigid, usually paler than the stem, minutely flocculose, base surrounded with white down, hollow.

On twigs, chips, &c., lying on the ground. Dannevirke, New Zealand. Australia, Tasmania, Ceylon, Europe, United States, Brazil.

Distinguished by the cinnamon colour of every part when moist, becoming almost white when dry, and the surface being very minutely broken up into squamules.

17. *Tubaria inquilina*, Fries, Syst. Myc., i., p. 264 (1821); Cke., Hdbk. Austr. Fung.; Sacc., Syll. v., no. 3597.

Pileus 1–2 cm. across, membranaceous, convex, then plane, at length more or less umbonate, hygrophanous, glabrous, slightly viscid, striate when moist, livid brown, tawny or hoary tan when dry; gills slightly decurrent, very broad behind, triangular, rather distant, brownish-tan, then umber; spores elliptical, dusky ferruginous, $8 \times 4\,\mu$; stem about 2·5 cm. long, about 2 mm. thick, thinner towards the base, tough, bay, covered at first with whitish fibrils and with white down at the base, hollow, often flexuous.

On twigs, chips, &c., lying on the ground. New Zealand. New South Wales, Europe.

Closely allied to *Tubaria crobula;* smaller, pileus striate when moist, glabrous from the first, and stem soon glabrous are the principal distinctive features.

18. *Tubaria crobula*, Fries, Epicr., p. 299; Sacc., Syll. v., no. 3596.

Pileus slightly fleshy, convex, then plane, obtuse, slightly viscid, not striate, at first covered with white floccose scales,

then naked and hoary, tan-colour, 1–2 cm. across; gills slightly decurrent, 2–3 mm. broad, crowded, rusty-brown; spores elliptical, rusty-brown, 10 × 6 μ; stem 2–3 cm. long, 2–3 mm. thick, often incurved or more or less wavy, brownish, covered with white floccose scales like the pileus, hollow.

On fragments of twigs, &c., lying on the ground in damp places. Dannevirke, New Zealand. Ceylon, Europe.

Distinguished from *Tubaria furfuracea* by the slightly viscid pileus, and by the densely scaly stem, which often bears more or less evident traces of a ring.

10. **Flammula**, Fries.

Pileus regular, fleshy, margin incurved when young; gills decurrent, becoming rust-coloured when mature; stem central; veil fibrillose, never forming a distinct ring on the stem; spores ferruginous.

Flammula, Fries, Syst. Myc., i., p. 250 (as a subgenus of *Agaricus*).

Closely allied to *Pholiota*, the difference between the two genera depending on the relative development of the veil, which in the present genus is fibrillose, and does not form a distinct ring on the stem, whereas in *Pholiota* the veil is interwoven, and forms a definite ring. Most species grow on wood; colours bright, orange-brown or yellow being most frequent. Growing on trunks, stumps, &c. Some are destructive parasites.

* *Gills adnexed.*

19. *Flammula purpureo-nitens*, Cke. and Mass., Grev., vol. xv., p. 94 (1887); Cke., Austr. Fung., p. 53; Sacc., Syll. v., no. 3393.

Pileus convex, fleshy, smooth, shining, purple-brown, margin even, about 2·5 cm. broad; gills adnexed, rather distant, broad, ferruginous; spores elliptical, tinted cinnamon-colour, 8 × 5 μ; stem 5 cm. long, 4–6 mm. thick, equal, ascending, fibrillose, solid, paler than the pileus, flesh pallid.

On wood. New Zealand. Victoria, Queensland, Western Australia.

20. *Flammula brunnea*, Massee, sp. nov.

Pileus subglobose, then expanding until almost plane, margin usually drooping, slightly umbonate, sometimes depressed round the umbo, 1–3 cm. across, even, glabrous, uniform dark-brown; flesh thin, pale greenish-yellow; gills adnexed, becoming almost or quite free as the pileus expands, crowded, rather broad, rusty-brown at maturity; spores elliptical, 5 × 3 μ, rusty; stem 3–7 cm. long, slender, almost equal, paler than the pileus, almost or quite smooth.

On logs. New Zealand.

Sent to Kew by Colenso mixed with *F. purpureo-nitens*, from which it differs, as also from every other described species, by the dark-brown pileus and greenish-yellow flesh. Fasciculate.

** *Gills adnate.*

21. *Flammula sapinea*, Fries, Syst. Myc., i., p. 239; Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 603; Austr. Fung., p. 52; Sacc., Syll. v., no. 3385.

Pileus hemispherical, then expanded, very obtuse, slightly floccosely squamulose superficially, then becoming broken up into minute squamules, tawny-orange, dry, paler towards the margin, 2·5–7 cm. across; flesh rather thick, compact; gills adnate, crowded, about 4 mm. broad, plane, yellow, then tawny-cinnamon; spores yellowish, elliptical, $8 \times 5\,\mu$; stem 2·5–5 cm. high, up to 1 cm. thick, solid or hollow, but stout and often irregular, fibrous, rooting, yellowish, becoming brownish when bruised.

On dead Conifers, also on the ground under pines. Northern Island, New Zealand. Australia, Europe, Ceylon, India, United States, Venezuela.

Usually more or less clustered. Smell strong. Stem short, often irregular.

22. *Flammula inopoda*, Sacc., Syll. v., no. 3373. *Agaricus inopus*, Fries, Syst. Myc., i., p. 251.

Pileus convex, then becoming almost plane, obtuse, even, smooth, slightly viscid when moist, honey-colour, disc reddish or with a reddish tinge all over, paler round the margin, becoming entirely pale, 2·5–8 cm. across; flesh thin, coloured like the pileus, white when dry; gills adnate, thin, crowded, about 4 mm. broad, yellowish-white, sometimes with a tinge of green, dry; spores broadly elliptical, ferruginous-brown, $10 \times 6\,\mu$; stem 6–12 cm. long, 2–8 mm. thick, often wavy, equal, rooting, adpressedly fibrillose, pale above, reddish-brown below, hollow.

On rotten trunks. Dannevirke, New Zealand. Europe.

Cæspitose or gregarious; somewhat resembling *Hypholoma fasciculare*, but distinguished by the long rooting base of the stem and the absence of a bitter taste.

23. *Flammula tilopoda*, Sacc., Syll. v., no. 3361. *Agaricus tilopus*, Kalchbr. and MacOwan, Grev., vol. , p. .

Pileus convex, then almost plane, slightly umbonate, covered with a separable viscid pellicle, pale-yellow, ½–2 cm. broad; flesh thin, greenish-yellow; gills adnate, crowded, rather narrow, rusty; spores elliptical, rust-colour, $5–6 \times 3\,\mu$;

stem 6–15 cm. long, almost equal, coloured like the pileus, with scattered fibrils or squamules, base downy.

On mossy trunks, or on the ground near stumps. New Zealand. South Africa.

Colenso's New Zealand specimens agree exactly with the type specimens of Kalchbrenner and MacOwan, now in the Royal Herbarium, Kew.

Usually growing in small clusters.

24. *Flammula xanthophylla*, Cke. and Massee, Austr. Fung., p. 50. *Agaricus crociphyllus*, Cke. and Mass., Grev., 16, p. 1.

Pileus subglobose, then broadly expanded but the margin persistently incurved, ochraceous or with a tinge of primrose-yellow, glabrous at first, then broken up into minute innate squamules or cracked in an areolate manner, 2·5–7 cm. diameter; flesh thick, compact, rigid when dry; gills adnate, with a decurrent tooth, rather distant, very broad, bright-yellow, then with a rusty tinge; spores elliptical, $10 \times 6\,\mu$; stem distinctly excentric or lateral, about 2·5 cm. long, stout, solid, more or less striate, coloured like the pileus, or paler.

On wood. Dannevirke, New Zealand. Australia.

A very distinct and well-defined species, known by the broad clear-yellow gills and excentric stem.

25. *Flammula spumosa*, Fries, Syst. Myc., i, p. 252; Sacc., Syll. v., no. 3358.

Pileus convex, then plane, sometimes rather umbonate, covered with a viscid separable cuticle, naked (without squamules or fibrils), pale-yellow, disc darker and usually with a rufous tinge, even, 2·5–5 cm. across; flesh rather thin, watery, pale yellowish-green; gills adnate, crowded, pale-yellow, then ferruginous, about 3 mm. broad; spores yellow-brown, elliptical, $9 \times 5\,\mu$; stem 5–10 cm. long, about 4 mm. thick, almost equal, more or less fibrillose, but with a distinct cuticle, hollow, pale-yellow, or the colour of the pileus.

In woods, especially of Conifers, on the ground; rare on trunks. New Zealand. Australia, Europe, United States.

Gregarious, more or less cæspitose, growing mostly on the ground, but springing from buried wood or humus. Inodorous, pileus yellow, stem yellow or olive-brown, often narrowed downwards. Very viscid in wet weather.

26. *Flammula penetrans*, Fries, Obs. Myc., i., p. 23; Austr. Fung., p. 52; Fries, Icon., ii., p. 17, tab. 118, fig. 2; Sacc., Syll., no. 3381.

Gregarious or cæspitose; pileus convex, then plane, obtuse,

often irregular, even, glabrous, surface not becoming broken up, dry, minutely silky under a lens when young, golden-tawny, but becoming pale and yellowish when old, 4–8 cm. across; flesh pallid, thickish at the disc, thinning out towards the margin; gills adnate and subdecurrent when young, often separating from the stem when old, 4–6 mm. broad, crowded, white, then yellow, stained and spotted with brown when old; spores elliptical, obliquely apiculate, 8 × 4–5 μ; stem 5–8 cm. long, up to 1 cm. thick, firm, equal, silky, then fibrillosely striate, yellowish, base with white down, sometimes rooting, imperfectly hollow; veil flocculose, white, but very fugacious and scarcely evident.

On rotten wood. Dannevirke, New Zealand. Australia, Europe, Siberia, Cuba, United States.

A very showy fungus, distinguished in the genus by the clear tawny-orange pileus and yellow gills becoming spotted with brown.

*** *Gills decurrent.*

27. *Flammula hyperion*, Cke. and Massee, Grev., vol. xvi., p. 72; Austr. Fung., p. 50; Sacc., Syll., suppl. ix., no. 438.

Pileus subglobose when young, then plano-convex, finally flattened, even, glabrous, tawny-orange, then reddish or brownish-orange, 4–8 cm. across; flesh 2–3 mm. thick, yellowish; gills decurrent, arcuate, rather distant, ochraceous, then tawny; spores 16–18 × 6–8 μ; stem about 5 cm. long, 1–2 cm. thick, becoming slightly thinner downwards, longitudinally grooved or striate, fibrillose and rather scaly, coloured like the pileus or paler.

On wood. New Zealand. Australia.

A very fine large species, and well marked, not approaching any other Australasian species. The spores are exceptionally large for a *Flammula*.

28. *Flammula vinosa*, Bull., Champ. France, tab. 54; Cke., Austr. Fung., p. 49; Sacc., Syll. v., no. 3323.

Pileus 2–4 cm. broad, centre very fleshy, becoming very thin at the margin, flesh white, convex, then expanded, at length often depressed and flexuous or wavy at the margin, dry, minutely flocculose, obscure rusty-cinnamon, usually with a tinge of purple; gills crowded, decurrent, simple, narrow, yellowish, then rusty; spores pale-umber, 5 × 3 μ; stem about 2·5 cm. long, 5–6 mm. thick, equal or thickened at the base, pale, delicately flocculose, solid.

On the ground. New Zealand. Victoria, Europe.

11. **Galera**, Fries.

Pileus regular, thin, often striate, margin straight and pressed to the stem when young; gills adnate, becoming almost free during expansion; stem central; spores rusty-ochre.

Galera, Fries, Syst. Myc., i, p. 264 (as a subgenus of *Agaricus*).

Most closely allied to *Naucoria*, but distinguished by the thin pileus, having the pileus straight when young. Corresponds in structure with *Mycena* and *Nolanea*. Growing on the ground.

29. *Galera tenera*, Schæff., t. 70; Massee, Brit. Fung.-Flora, ii., p. 144, figs. 5, 6, p. 3; Sacc., Syll. v., no. 3537.

Pileus conico-campanulate, obtuse, thin, hygrophanous, entirely yellowish rust-colour when moist, even, pale and rather atomate when dry, 1·5–2·5 cm. high and broad; gills adnate, crowded, ascending, rather broad, cinnamon; spores 12–13 × 7 μ; stem 6–10 cm. high, slender, straight, fragile, equal or slightly narrowed upwards, rather shining, striate upwards, coloured like the pileus.

Among short grass, &c. New Zealand. Australia, South Africa, Europe, United States, Brazil.

Variable in size, sometimes quite minute, at others exceeding the measurements given above. All one colour when moist, and the pileus very slightly striate; even, and pale everywhere when dry.

12. **Naucoria**, Fries.

Pileus regular, slightly fleshy, margin incurved when young; gills adnexed or adnate, never decurrent; stem central; spores rusty-brown.

Naucoria, Fries, Syst. Myc., i., p. 260 (as a subgenus of *Agaricus*).

Differs from *Galera*, its nearest ally, in the margin of the pileus being incurved when young. Growing on the ground.

**Pileus umbonate.*

30. *Naucoria acuta*, Sacc., Syll. v., no. 3456. *Agaricus (Naucoria) acuta*, Cooke, Grev., xiv., 841 (1886).

Pileus fleshy, conico-campanulate, acutely umbonate, glabrous, even, opaque, ochraceous, 3–5 mm. broad; gills adnate, somewhat crowded, yellowish, then cinnamon, edge paler; spores amber, elliptical, 7–8 × 5 μ; stem slender, hollow, equal, adpressedly fibrillose, yellowish-white, 2·5 cm. long, 1 mm. thick.

On rotten logs. New Zealand.

A very beautiful little endemic species, usually densely clustered or gregarious. Pileus somewhat orange-rusty at times. Apparently not uncommon in New Zealand.

31. *Naucoria sideroides*, Bull., Champ. France, pl. 588; Sacc., Syll. v., no. 3451.

Pileus campanulate, then expanded. umbonate, glabrous, viscid, yellowish-cinnamon, becoming ochraceous-tan and rather shining when dry, margin entire, incurved when young, 1·5–2·5 cm. broad; flesh very thin, white; gills adnate, with a decurrent tooth, sometimes slightly sinuate, narrow, crowded, ochraceous, then cinnamon; spores elliptical, pale-yellow, 8–10 × 4–6 μ; stem 5–8 cm. long, 2–4 mm. thick, slightly narrowed upwards, even, glabrous or sprinkled with white powder at the apex, pallid, then yellowish, rusty below and becoming brownish, stuffed or hollow.

On trunks, chips, &c.; rarely on the ground. Dannevirke, New Zealand. Europe.

32. *Naucoria melinoides*, Fries, Epicr., p. 195; Austr. Fung., p. 53; Sacc., Syll. v., no. 3437.

Pileus submembranaceous, convex, then almost plane, slightly gibbous or broadly umbonate, even, glabrous, tawny when moist, ochraceous when dry, or sometimes whitish, slightly striate at the margin when old, 1·5–2·5 cm. broad; gills adnate, triangular-oblong, crowded, margin minutely dentate, somewhat tawny or honey-colour; spores elliptical, 10–12 × 4–5 μ; stem 3–4 cm. long, 2–3 mm. thick, equal, or slightly thinner upwards, coloured like the pileus, base paler, sprinkled with white meal at the apex, rather firm, hollow.

Among short grass, &c. Dannevirke, New Zealand. Australia, Europe.

Gills very variable, sometimes adnexed, at others broadly adnate, honey-colour or cinnamon, retaining their colour after the pileus has become dry and ochraceous or whitish.

33. *Naucoria nasuta*, Kalchbr., Grev., vol. viii., p. 152, pl. 142, fig. 9; Austr. Fung., p. 54; Sacc., Syll. v., no. 3426.

Pileus thin, globose, then hemispherical, with a prominent elongated umbo, coarsely striate at the margin, remainder even, glabrous, 1–1·5 cm. high and broad, ochraceous-yellow; gills emarginate, with a decurrent tooth, rather crowded, broad, ventricose, rusty-orange; spores elliptical, 13–14 × 7–8 μ; stem about 5 cm. long and 2 mm. thick, equal, twisted, fibrillose, rusty-orange, fistulose.

On the ground. Dannevirke, New Zealand. New South Wales.

Distinguished by the prominent umbo.

34. *Naucoria temulenta*, Fries, Epicr., p. 199; Austr. Fung., p. 55; Massee, Brit. Fung.-Flora, ii., p. 165, figs. 8, 9, p. 3; Sacc., Syll. v., no. 3486.

Pileus almost membranaceous, campanulate, then convex, somewhat umbonate, never depressed; margin striate, glabrous, ferruginous when moist, ochraceous and even when dry, 1·5–2·5 cm. broad; gills adnate, rather distant, narrowed in front, lurid, then rusty-umber; spores elliptical, 12 × 6 μ; stem about 5 cm. long and 3 mm. thick, wavy or flexuous, glabrous, polished, apex slightly mealy, hollow, but the cavity often containing a loose pith.

On the ground, in damp woods, &c. Dannevirke, New Zealand. Australia, Europe.

Allied to *Naucoria pediades*, from which it differs in the pileus being more or less umbonate, never depressed, and striate when moist.

** *Pileus obtuse.*

35. *Naucoria fraterna*, Cke. and Massee., Grev., vol. xvi., p. 31; Sacc., Syll., suppl. ix., no. 458.

Cæspitose; pileus convex, depressed and umbilicate, even, glabrous, yellowish-rusty, 1–1·5 cm. broad; flesh thin, whitish; gills adnate, rather distant, broad, margin entire, yellowish rust-colour; spores elliptical, 10 × 6 μ; stem 2·5–5 cm. long, 2 mm. thick, slightly curved near the base, glabrous, coloured like the pileus, fistulose.

On trunks and stumps. Dannevirke, New Zealand. Australia.

Readily recognised by the cæspitose or tufted habit of growth, and in growing on stumps. Both these characters are unusual in the genus *Naucoria*.

36. *Naucoria pediades*, Fries, Epicr., p. 197; Sacc., Syll. v., no. 3469; Austr. Fung., p. 54.

Pileus thin, convex, then becoming plane, obtuse, often more or less depressed, never umbonate, dry, at length minutely rivulose or radially wrinkled, but never striate, yellowish-ochre, then pale tan-colour, 2·5–5 cm. across; gills adnexed, crowded at first, becoming rather distant as the pileus expands, about 4 mm. broad, at first brownish, then dingy-cinnamon; spores dingy-ferruginous, elliptical, 10–12 × 4 – 5 μ; cystidia fairly numerous, 30–50 × 8 – 10 μ; stem 5–8 cm. long, 2–4 mm. thick, somewhat flexuous, silky, yellowish, base slightly bulbous, stuffed with a distinct pith.

Among grass. New Zealand. Australia, Ceylon, South Africa, Europe, Siberia, United States.

Allied to *Naucoria sideroides*. For distinctive features, see note under last-named species.

37. *Naucoria semiorbicularis*, Bull., Champ. France, tab. 422; Austr. Fung., p. 55; Sacc., Syll. v., no. 3470.

Pileus hemispherical, then expanded, even, glabrous, slightly viscid, at length rivulose, tawny-ferruginous, ochraceous when dry, 2·5–5 cm. across when expanded; flesh thin, whitish; gills adnate, rarely more or less sinuous, very broad, crowded, pallid, then rusty-orange; spores elliptical, 10 × 5–6 μ; stem 5–10 cm. long, 2–4 mm. thick, tough, nearly straight, pale-ferruginous, shining, base usually darker, hollow, the cavity containing a free strand which readily splits into fibrils.

Among short grass, &c. Waitaki, New Zealand. Australia, India, Europe, United States.

Allied to *Naucoria pediades*, from which it is readily distinguished by the viscid pileus, broad gills, and rusty or ferruginous stem.

38. *Naucoria siparia*, Fries, Epicr., p. 201; Austr. Fung., p. 55; Sacc., Syll. v., no. 3507.

Pileus convex, then obtuse, not umbilicate, rusty-red, densely clothed with fasciculate tufts of down resembling minute scales, 1–2 cm. broad; gills adnate, broad, rather distant, coloured like the pileus, margin flocculose; spores 7–8 × 5–6 μ; stem about 2·5 cm. long, slender, equal, squamulose up to the ring, apex glabrous, coloured like the pileus.

On the ground, twigs, &c. New Zealand. Australia, Europe.

Distinguished by the squamulose stem and pileus. *Naucoria crinacea*, a species not recorded for New Zealand, closely resembles the present, but differs in the umbilicate pileus, stem squamulose nearly or quite up to the apex, and the margin of the gills quite entire.

13. **Hebeloma**, Fries.

Pileus regular, often rather fleshy, cuticle of the pileus not torn into scales or fibrils, smooth, often viscid, margin incurved when young; veil fibrillose or absent; gills adnexed and sinuate; stem central, fibrous; spores dingy-ochraceous.

Hebeloma, Fries, Syst. Myc., i., p. 249 (as a subgenus of *Agaricus*).

Closely allied to *Inocybe*, which differs mainly in having the cuticle of the pileus torn into scales or fibrils. Agrees structurally with *Tricholoma* in the *Leucosporæ*. Growing on the ground.

39. *Hebeloma strophosum,* Fries, Epicr., p. 161; Sacc., Syll. v., no. 3320.

Pileus subglobose, soon expanding and becoming convexo-plane and rather umbonate, fragile, viscid when wet, disc dark-tan, even, margin pale and silky from the remains of the veil, but not squamulose, 1·5–3 cm. across; flesh rather thin, watery; gills slightly adnexed, ventricose, 4–8 mm. broad, pallid, then dingy-cinnamon; spores 7-8 × 4 μ; stem 2·5–5 cm. long, hollow, about 6 mm. thick, equal, fragile, pallid and becoming brownish downwards, adpressedly silky, with a more or less perfect silky ring near the apex.

Grassy spots. Wairarapa, Northern Island, New Zealand. Europe.

Distinguished more especially by the hollow stem, which is not rooting, and the silky ring very near to the apex of the stem.

14. **Pholiota,** Fries.

Pileus regular, fleshy; gills adnate or adnexed, rust-coloured at maturity; stem central, with a distinct ring; spores rusty-orange.

Pholiota, Fries, Syst. Myc., i., p. 240 (as a subgenus of *Agaricus*).

The only genus in the *Ochrosporæ* having the stem furnished with a persistent ring. Growing on trees; some species are destructive parasites; a few species are very showy in colour and form.

* *Pileus obtuse, not umbonate.*

40. *Pholiota adiposa,* Fries, Syst. Myc., i., p. 242; Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 602; Sacc., Syll. v., no. 3107.

Pileus convex, obtuse, then expanding, glutinous, yellow, with superficial concentrically arranged seceding darker squarrose scales, 5–12 cm. across; flesh whitish, compact at the disc; gills adnate, 6–8 mm. broad, yellow, then rusty-orange; spores elliptical, rusty-orange, 7 × 3 μ; stem 7–12 cm. long, up to 2 cm. thick, base somewhat bulbous, remainder more or less equal throughout, yellow, ornamented with concentrically arranged rusty-orange evanescent scales up to the superior, floccose, radiating ring, stuffed.

On decaying parts of trees. Cape Turnagain, Northern Island, New Zealand. Europe, United States.

A very showy fungus when well grown. Usually cæspitose, and forming large clusters. Distinguished by the glutinous pileus and stem, both of which are at first ornamented with rusty-orange or ferruginous squarrose or spreading scales. The scales appear eventually to deliquesce in the gluten, which

is washed away in rainy weather, leaving the pileus and stem naked. In dry weather the pileus is shiny, due to the dried gluten. Poisonous.

41 *Pholiota pudica*, Bull., Champ. France, tab. 597, fig. 2, R, S; Austr. Fung., p. 44; Sacc., Syll. v., no. 3065.

Pileus fleshy, convex, then expanded, or even depressed, obtuse, even, dry, glabrous, white or slightly tinged with tawny; 2·5–8 cm. across; gills adnexed, rounded behind, ventricose, about 4 mm. broad, whitish, then tawny; spores elliptical, 6–7 × 3·5 μ; stem 2·5–5 cm. long, 5–10 mm. thick, straight or most frequently curved and ascending, equal, even, white, solid; ring superior, persistent, white, spreading.

On trunks. New Zealand. Australia, Europe.

Simple or cæspitose; stem sometimes excentric and curved at the base. According to Bulliard's figure, quoted above, the pileus is pruinose at the disc.

42. *Pholiota pumila*, Fries, Eleuch., p. 29 (1828); Cke., Austr. Fung., p. 46; Sacc., Syll. v., no. 3135.

Pileus rather fleshy, hemispherical, obtuse, even, hygrophanous, glabrous, ochraceous or rarely brownish-cinnamon, 1–1·5 cm. broad; flesh dingy; gills adnate, crowded, about 3 mm. broad, pallid-yellowish; spores 8–10 × 5–6 μ; stem 2·5–5 cm. long, about 2 mm. thick, yellow, somewhat fibrillose, hollow; ring superior, floccose, not interwoven into a membrane, only forming a zone round the stem.

On the ground, among grass and moss. New Zealand. Victoria, New South Wales, Europe.

43. *Pholiota erebia*, Fries, Syst. Myc., i., p. 246; Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 602; Austr. Fung., p. 43; Sacc., Syll. v., no. 3050.

Pileus convex, then flattened, glabrous, rather viscid, hygrophanous, margin striate, umber, often with an olivaceous tinge, ochraceous-tan and often rugulose or wrinkled when dry, 2·5–5 cm. across; flesh thin, dingy; gills adnate, rather distant, about 4 mm. broad, pallid, then dingy-cinnamon; spores elliptical, 10–12 × 4–6 μ; stem about 5 cm. long, 6–8 mm. thick, equal, somewhat striate, soon pale, hollow; ring superior, soon pendulous, with the margin upturned, more or less striate.

On the ground. Ahuriri, Northern Island, New Zealand. Australia, Europe.

Distinguished by the dark-umber colour of the pileus when moist and the superior ring. The pileus is sometimes more or less umbonate, at others slightly depressed; somewhat fragile.

44. *Pholiota marginata*, Batsch, fig. 207; Austr. Fung., p. 45; Sacc., Syll. v., no. 3130.

Pileus convex, then expanded, hygrophanous, moist, glabrous, margin striate, honey-colour, becoming pale-tan when dry, about 2·5 cm. across; flesh thin; gills adnate, crowded, about 2 mm. broad, watery-cinnamon; spores 7–8 × 4 μ; stem 3–5 cm. long, 2–4 mm. thick, equal or slightly thickened at the base, soft, not scaly, mealy above the fugacious ring, pale-tan, base darker and surrounded with white down, hollow.

On trunks, heaps of leaves, &c. Dannevirke, New Zealand. Australia, Europe, Siberia.

Allied to *Pholiota mutabilis*, but differing in the stem below the ring not being scaly, but only somewhat fibrillose; commonly smaller; solitary or gregarious, rarely cæspitose.

** *Pileus umbonate.*

45. *Pholiota squarrosa*, Müll., in Fries' Syst. Myc., i., p. 143; Sacc., Syll. v., no. 3093.

Pileus campanulate, then expanded, often broadly and obtusely umbonate, dry, yellowish-brown, covered with darker persistent squarrose scales, 5–10 cm. across; flesh firm, thickish, white but usually tinged yellow or green; gills slightly decurrent, crowded, about 4 mm. broad, pale-olive, then rusty; spores rusty, 8 × 4 μ; stem 7–12 cm. long, up to 1 cm. thick, slightly narrowed towards the base, more or less wavy or ascending, pale tawny-yellow or brown, and covered with darker recurved scales up to the superior spreading ragged ring, smooth and pale above the ring, stuffed.

On trunks, on and near stumps, &c. Dannevirke, New Zealand. Europe, United States.

Usually growing in dense clusters; smell strong, dull rusty-orange, with darker squarrose or spreading scales on the pileus and stem. Distinguished from *Pholiota adiposa* by the darker colour of the entire fungus and the persistent scales. Poisonous.

46. *Pholiota mutabilis*, Schæffer, t. 9.; Austr. Fung., p. 45; Sacc., Syll. v., no. 3129.

Pileus convex, then expanded, usually obtusely umbonate, sometimes depressed round the umbo, glabrous, deep cinnamon-colour, becoming paler when dry, size very variable, 2·5–10 cm. across; flesh thin; gills adnate and slightly decurrent, crowded, rather broad, pallid, then cinnamon-colour; spores 9–11 × 5–6 μ; stem 3–10 cm. long, rigid, nearly equal, covered with squarrose scales up to the superior membranaceous ring which is minutely scaly outside, brownish below,

paler upwards and smooth above the ring, stuffed, then hollow, often incurved and ascending.

On trunks and stumps; rarely on the ground, and then springing from buried wood. Dannevirke, New Zealand. Australia, Tasmania, Europe, Siberia, United States.

An elegant species when well grown. Known from *Pholiota squarrosa* by the glabrous pileus. Most closely allied to *Pholiota marginata*, under which species the differences are indicated.

47. *Pholiota unicolor*, Vahl, Flor. Dan., tab. 1071, fig. 1; Sacc., Syll. v., no. 3132.

Pileus 1–2 cm. across; flesh thin; campanulate, then convex, slightly umbonate, glabrous, almost even, at length slightly striate at the margin, hygrophanous, bay, ochraceous when dry; gills adnate, receding, broad, almost triangular, ochraceous-cinnamon; spores $9–10 \times 5\,\mu$; stem 2–5 cm. long, about 2 mm. thick, almost glabrous and equal, coloured like the pileus, stuffed, then hollow, often slightly curved at the base; ring superior, slender, entire.

On trunks and branches. New Zealand. South Africa, Europe.

Subcæspitose; constant in habit, form, and colour.

RHODOSPORÆ.

ANALYSIS OF THE GENERA.

* *Pileus excentric; gills decurrent.*

15. CLAUDOPUS.

** *Pileus regular; gills adnate or adnexed.*

16. LEPTONIA.

*** *Pileus regular; gills free.*

17. PLUTEUS.

15. **Claudopus**, W. G. Smith.

Pileus excentric, lateral, or resupinate; gills more or less decurrent; stem very short or absent; spores salmon-colour.

Claudopus, W. G. Sm., *Clavis Agaric.*, p. 17.

The species are minute, distinguished by the excentric or resupinate pileus, rudimentary or obsolete stem, and salmon-coloured spores. Agreeing in structure with the simplest forms of *Pleurotus*, which differ in the white spores. Growing on dead wood, herbaceous stems, &c.

48. *Claudopus depluens*, Batsch, Consp. Fung., f. 122; Massee, Fung.-Flora, ii., p. 237, figs. 1–3, p. 236; Sacc., Syll. v., no. 3041. *Agaricus depluens*, Batsch, *loc. cit.*

Pileus almost membranaceous, watery, fragile, more or less

convex, with the margin incurved, rather silky, whitish or with a tinge of red, more or less hoary when dry, 1–1·5 cm. across; gills broad, ventricose, crowded, pale-grey, then reddish; spores pink, globose, rather coarsely warted, 5–6 μ diameter. The pileus is either almost sessile or furnished with a short lateral or sometimes almost central stem.

On the ground, attached to moss, twigs, &c.; also on wood. Dannevirke, New Zealand Australia, Europe, United States.

In the young condition, while the gills are yet white, the present species might be mistaken for a *Pleurotus;* the pink warted spores readily show its affinities at maturity. The present species is quite distinct from *Crepidotus epigæus*, although given as a synonym under the last-named species by Cooke, in Austr. Fung., no. 299, p. 59. *C. depluens* has been also received from Queensland.

16. **Leptonia,** Fries.

Pileus regular, thin, umbilicate, margin incurved when young; gills adnate or adnexed, but soon separating from the stem, and then appearing as if free; stem central, externally cartilaginous and polished; spores salmon-colour.

Leptonia, Fries, Syst. Myc., i., p. 201 (as a subgenus of *Agaricus*).

Allied to *Nolanea*, but distinguished by the umbilicate pileus having the margin incurved when young. Corresponding in structure to *Collybia* in the *Leucosporæ*. Rarely on wood; mostly in open pastures. Tints of blue or green are not uncommon in the genus.

49. *Leptonia asprella*, Fries, Epicr., p. 154; Massee, Brit. Fung.-Flora, ii., p. 256; Sacc., Syll. v., no. 2054.

Pileus somewhat membranaceous, convex, then expanded, umbilicate, and there more especially downy, then squamulose, sometimes glabrous (except the disc), sometimes fibrillose, hygrophanous, at first smoke-colour, or mouse-colour, then livid grey, 2·5–4 cm. across; gills adnate, then separating from the stem and becoming free, rather distant, plane, equally narrowed from the stem to the margin, greyish-white, edge quite entire and of the same colour as the remainder; spores elliptical, 10–12 × 6–8 μ; stem 2·5–5 cm. long, not more than 2 mm. thick, equal, straight, even, glabrous, cartilaginous, hollow, livid, fuscous, green and blue mingled, &c., base with white down.

Among grass. New Zealand. Europe.

Some specimens have the pileus squamulose everywhere, some forms resemble a *Nolanea;* pileus hemispherical, then campanulate, disc sometimes with a minute depression, sometimes with a papilla (Fries).

50. *Leptonia placida*, Fries, Syst. Myc., i., p. 202 (1821); Sacc., Syll. v., no. 2920.

Pileus 2–6 cm. across, flesh thin, campanulate, then convex, not striate, the blackish disc densely downy, the remainder covered with blackish fibrils or squamules on a greyish-white ground, squamules arranged concentrically when old; gills adnexed, very broad behind, not ventricose, crowded, whitish, as is also the margin; stem 5–8 cm. long, 3 mm. thick, equal, very rigid, having white meal at the slightly thickened apex, and with black points or squamules when seen under a lens, remainder glabrous, even, dark-blue or blackish-blue.

On trunks or on the ground. New Zealand. Europe.

Distinguished from *Leptonia lampropoda* by the squamulose pileus and the minute black points on the upper part of the stem.

51. *Leptonia æthiops*, Fries, Epicr., p. 152 (1836); Sacc., Syll. v., no. 2924.

Pileus 1·5–2·5 cm. across, flesh thin, plane, then depressed, not striate, fibrillosely virgate, shining, sooty-black, not hygrophanous, but young specimens are black and shining when dry; gills adnexed or adnate, straight or ventricose, whitish, edge same colour and quite entire; stem 3–5 cm. long, hardly a line thick, glabrous, blackish-brown, having black points near the top; spores irregularly nodulose, salmon-colour, $10 \times 7\ \mu$.

Among grass, on the ground. New Zealand. Europe.

Distinguished from its ally, *Leptonia lampropoda*, by the pileus being depressed from the first, and the slender stem with black points at its apex.

52. *Leptonia lampropoda* (*Agaricus (Leptonia) lampropus*), Fries, Epicr., p. 152; Austr. Fung., p. 40; Sacc., Syll. v., no. 2923.

Pileus convex, then expanded, not becoming campanulate, obtuse, at length depressed, almost even when young, never striate, at length more or less squamulose, mouse-colour, or sooty-grey with a blue tinge, becoming paler but not hygrophanous, about 2·5 cm. across; flesh thin; gills adnate, easily separating from the stem and appearing as if free, ventricose, white, then pale flesh-colour; spores irregularly nodulose or angular, $10–11 \times 6–7\ \mu$; stem 2·5–3·5 cm. long, up to 4 mm. thick, entirely cartilaginous, glabrous, even, not punctate upwards, usually bluish-violet, hollow.

Among grass, &c. Dannevirke, New Zealand. Europe, Australia.

Distinguished from several nearly allied species by the

pileus not being umbilicate and not in the least striate, and the stout stem.

17. **Pluteus**, Fries.

Pileus regular; gills quite free from the stem; stem central, ring and volva entirely absent; spores pale salmon-colour.

Pluteus, Fries, Epicr., p. 140 (as a subgenus of *Agaricus*).

Distinguished among the *Rhodosporæ* by the free gills and absence of volva and ring. The species grow on wood.

53. *Pluteus cervinus*, Schæff., Icon., tab. 10 (1800); Cke., Austr. Fung., p. 38; Sacc., Syll. v., no. 247.

Generally solitary. Pileus 4–10 cm. across, flesh white, thick at the disc, becoming very thin towards the margin, campanulate, then expanded, even, at first glabrous, then becoming broken up into fibrillose squamules that soon disappear, smoky, with a yellow, brown, or fawn-coloured tinge; gills free, crowded, 4–8 mm. broad, white, then salmon-colour; spores broadly elliptical, smooth, 7–8 × 5–6 μ; cystidia ventricose, often spinose at the apex; stem 5–12 cm. long, 1 cm. and more thick, equal, pale and sprinkled with blackish fibrils, solid.

On trunks and stumps. New Zealand. Victoria, Tasmania, Ceylon, South Africa, Europe.

Leucosporæ.

Analysis of the Genera.

A. Margin of gills split; split portions curved outwards.

18. Schizophyllum.

B. Margin of gills not split; entire fungus soft, soon decaying after maturity.

* *Gills decurrent; pileus regular.*

19. Cantharellus. Gills narrow, edge thickened.

20. Omphalia. Edge of gills sharp; stem cartilaginous and polished outside.

21. Clitocybe. Edge of gills sharp; stem fibrous externally.

22. Hygrophorus. Edge of gills sharp; plants brittle, watery. (Some species have the gills adnate, or almost free.)

** *Gills decurrent; stem excentric or lateral.*

23. Pleurotus.

*** *Gills adnate or adnexed.*

† Ring on stem absent.

24. Laccaria. Gills becoming mealy with the globose warted spores.

25. Collybia. Gills not mealy; margin of pileus incurved when young.

26. Mycena. Gills not mealy; margin of pileus straight when young.

27. Tricholoma. Gills not mealy, sinuate.

†† Ring present on stem.

28. Armillaria.

**** *Gills free.*

29. Lepiota. Volva absent from base of stem.
30. Amanita. Volva present at base of stem.

C. Margin of gills entire; entire fungus coriaceous or corky, drying up at maturity, and not deliquescing.

* *Gills forked, edge thickened.*

31. Xerotus.

** *Edge of gills sharp, entire.*

32. Marasmius. Stem central.
33. Panus. Stem excentric, lateral, or absent.

D. Margin of gills toothed or eroded.

34. Lentinus.

E. Pileus sessile, corky, growing horizontally.

35. Lenzites.

18. **Schizophyllum**, Fries.

Pileus thin, without flesh, dry, flaccid and tough, tomentose, sessile, fan-shaped; gills radiating from the point of attachment, forking, splitting along the edge, the split portions curving away from the line of splitting, dry; spores hyaline or tinged with brownish-purple.

Schizophyllum, Fries, Obs., i., p. 103; Sacc., Syll. v., p. 654.

A small but cosmopolitan genus, most abundant in tropical and subtropical countries. Characterized by the thin dry substance of the entire fungus and the gills splitting along the edge. Growing on wood.

54. *Schizophyllum commune*, Fries, Syst. Myc., i., p 333; Austr. Fung., p. 100, fig. 47; Flora N.Z., ii., p. 177; Hdbk. N.Z. Flora, p. 606; Sacc., Syll. v., no. 2705.

Pileus very thin, dry, sessile, resupinate or usually attached laterally and spreading like a fan, entire or variously lobed; pileus tomentose, greyish, 1–6 cm. broad; gills radiating from the point of attachment, forking, narrow, dry, splitting along the edge, split surfaces minutely downy, grey, then tinged purplish-brown; spores hyaline, elliptical, apiculate, 5-6 $\times$ 4 μ.

On trunks, branches, and worked wood. Common in New Zealand, and very general in tropical and subtropical regions, becoming rare in colder regions.

Very variable, sometimes resupinate and almost entire, usually lateral and spreading from the point of attachment in a fan-like manner. Sometimes cut into deep narrow lobes.

19. **Cantharellus,** Adans.

Pileus often fleshy but thin in small species, often lobed or irregular; gills more or less decurrent, narrow, edge thick, entire; stem central, excentric, or absent; spores white, smooth.

Cantharellus, Adanson, Fung. Ord., v.

Distinguished among white-spored genera with decurrent gills by the narrow entire gills having the edge blunt or thickened. Growing on the ground.

55. *Cantharellus umbriceps*, Cke., Grev., vol. viii., p. 54, pl. 132, figs. 1, 2; Sacc., Syll. v., no. 1902.

Pileus fleshy, soft, subglobose, then expanding, then depressed, margin incurved, glabrous, umber, about 3 cm. diameter; gills very narrow, thick, forked, not crowded, dingy-orange; stem about 4 cm. long and 1 cm. thick at the slightly swollen base, solid, white with a tinge of yellow; spores globose, 4 μ diameter.

On the ground. Maungaroa, New Zealand.

As the species was founded upon the examination of a single specimen, accompanied by a coloured drawing, it is probable that the size and some minor details given above may require modification.

20. **Omphalia,** Fries.

Pileus symmetrical, usually very thin, depressed or infundifuliform; gills truly decurrent, edge thin, entire; stem distinctly cartilaginous externally, tubular, but the cavity is frequently stuffed, especially when young, usually widening upwards into the pileus; spores hyaline

Omphalia, Fries, Syst. Myc., i., p. 162 (as a subgenus of *Agaricus*).

Agreeing with *Clitocybe* in the decurrent gills, but readily known by the externally polished, cartilaginous stem. The species are with few exceptions small, and many grow on wood, twigs, &c. Smell obsolete, or nearly so, in all the species.

* *Pileus even.*

56. *Omphalia anthiceps*, Berk. and Curt., Journ. Linn. Soc. (Bot.), vol. x., p. 286; Sacc., Syll. v., no. 1222.

Densely tufted; pileus deeply umbilicate, often somewhat umbonate but the umbo sunk in the central depression, thin, even, glabrous, white, disc tinged brown, 1–1·5 cm. broad; gills adnato-decurrent, distant, rather broad, white; spores subglobose, 4–5 μ diameter; stem 1–1·5 cm. long, slender, glabrous, white, hollow.

Densely cæspitose, on decaying logs. New Zealand. Cuba.

Distinguished by the much-crowded habit, and the white pileus having the centre depressed and tinged brown.

56A. *Omphalia leonina*, Massee.

Pileus campanulate, slightly umbilicate, even, glabrous, very thin, extreme margin sometimes slightly upturned, rich tawny-yellow, 4–8 mm. across; gills deeply decurrent, paler than the pileus, very distant, thick; spores broadly elliptical, hyaline, smooth, $5 \times 3\ \mu$; stem about 2 cm. long, slender, expanding upwards into the pileus, polished, rich orange-brown, with delicate tawny scurf at the base.

Found at Kew Gardens, England, on a piece of dead wood covered with a fern that had come direct from New Zealand.

Allied to *Omphalia colensoi*, but distinguished from this and every other species by the tawny-yellow pileus, very thick distant gills, and the brown stem.

** *Pileus striate.*

57. *Omphalia fibula*, Bull., Champ. France, tab. 186, fig. 1; Sacc., Syll. v., no. 1285.

Pileus membranaceous, almost translucent, rather tough, usually umbilicate, then infundibuliform; margin drooping, then expanded, sometimes conical and more or less papillate; glabrous, hygrophanous, striate and orange-yellow or sometimes brownish or quite white when moist, pale when dry, up to 1·5 cm. across, usually much smaller; gills deeply decurrent, distant, distinct, broad, whitish; spores elliptical, $4–5 \times 2\ \mu$; stem 2–3 cm. long, very slender, coloured like the pileus, stuffed, then hollow, sometimes more or less tinged with violet at the apex.

Damp places, amongst moss, &c. New Zealand. Australia, Europe, United States.

Often growing on ground that has been burnt. Slender and delicate, but rather tough.

58. *Omphalia stellata*, Fries, Syst. Myc., i., p. 163; Sacc., Syll. v., no. 1257.

Entirely white. Pileus truly membranaceous, convex, umbilicate, pellucidly striate, glabrous, 1–1·5 cm. across; gills decurrent, rather distant, thin, not triangular; spores elliptical, $6–7 \times 4\ \mu$; stem usually about 2 cm. long, very slender, fragile, stuffed, then hollow, often curved, base dilated and radially strigose or hairy.

On logs, stumps, &c. Dannevirke, New Zealand. Europe.

Often gregarious. Distinguished by the semitranslucent white colour of every part, and the strigose base of the stem. Pileus frequently excentric.

59. *Omphalia colensoi*, Berk., Flora N.Z., ii., p. 173; Hdbk. N.Z. Flora, p. 602 (as *Agaricus (Omphalia) colensoi*); Sacc., Syll. v., no. 1264.

Pileus thin, rather deeply umbilicate, sometimes almost funnel-shaped, glabrous, entirely covered with very fine radial wrinkles (when dry), margin incurved, 1–1·5 cm. across; gills pallid, rather narrow, slightly decurrent, thin and not distant; spores hyaline, subglobose, about 4 × 3 μ; stem 1–1·5 cm. long, slender, minutely scurfy, then becoming glabrous.

On the ground, amongst sand and scraps of wood, wet logs, &c. Ngaawapurua, Northern Island, New Zealand.

The pileus appears to have been whitish when fresh, stem darker. Distinguished from *Omphalia umbellifera* by the thin, rather close gills. Type specimens examined.

60. *Omphalia pyxidata*, Bulliard, Champ. France, tab. 568, fig. 2; Sacc., Syll. v., no. 1199.

Pileus membranaceous, umbilicate, then infundibuliform, almost glabrous; radially striate and brick-red or rufescent when moist, hygrophanous; whitish and minutely silky when dry; 1·5–2·5 cm. across; gills decurrent, rather distant, narrow, flesh-colour, then yellowish; spores 7–8 × 5–6 μ; stem 2–2·5 cm. long, 2 mm. thick, even, tough, pale-rufescent, stuffed, then hollow.

Among short grass, &c. Dannevirke, New Zealand. Europe, Australia.

Characterized by the dull-red tinge of the entire fungus and the narrow gills.

Specimens of this species have been found amongst the New Zealand fungi sent to Kew by Colenso, hence its occurrence does not rest on the doubtful identification of the specimens alluded to in the "Handbook of the New Zealand Flora," p. 602.

61. *Omphalia umbellifera*, Linn., Suec., no. 1192; Flora N.Z., ii., p. 173; Hdbk. N.Z. Flora, p. 602; Austr. Fung., p. 28; Sacc., Syll. v., no. 1241.

Pileus convex, then almost plane and obconic, often more or less wavy and upturned, radiately striate when moist, even and silky when dry, 1·5–2 cm. across; gills decurrent, very distant, broad behind, whitish or coloured like the pileus; spores broadly elliptical, 7 × 4 μ; stem about 1 cm. long and 2 mm. thick, coloured like the pileus, base downy, imperfectly hollow.

On the ground. Northern Island, New Zealand. Australia, Tasmania, Ceylon, Europe, Greenland, United States.

Very variable in colour; most commonly whitish, becoming shining white when dry, but also grey, yellow, brownish,

green, &c. The margin of the pileus is incurved and crenulate when young. Known among allied forms by the thicker almost flat pileus and the broad somewhat triangular very distant gills.

21. **Clitocybe,** Fries.

Pileus generally fleshy at the disc, and becoming thin towards the margin, flexible or tough, for the most part plano-depressed or infundibuliform, margin involute; gills decurrent, edges thin, entire; stem central, externally fibrous, somewhat elastic, stuffed, often becoming hollow; veil obsolete; spores hyaline, elliptical or subglobose.

Clitocybe, Fries, Syst. Myc., i, p. 70 (as a subgenus of *Agaricus*).

Differs from *Omphalia,* its closest ally, in the stem being fibrous externally, and not polished or cartilaginous. The gills are also usually much less decurrent, being, in fact, sometimes only slightly so *Pleurotus* differs in the lateral or excentric stem, and *Hygrophorus* in the waxy gills. Finally, *Cantharellus* is separated by the narrow, distant, thick-edged gills. Growing on the ground.

62. *Clitocybe infundibuliformis*, Schæffer, t. 212; Flora N.Z., ii., p. 173; Hdbk. N.Z. Flora, p. 602; Austr. Fung., p. 15; Sacc., Syll. v., no. 595.

Pileus convex when young, then depressed, umbo blunt, margin incurved, at maturity becoming softer and flaccid and completely infundibuliform or funnel-shaped, up to 8 cm. across; disc fleshy, remainder thin, firm when young, yellowish flesh-colour, then buff, becoming pallid or whitish; gills decurrent, rather crowded, narrowed to both ends, soft, white; spores $5–6 \times 3–4 \mu$; stem 7–10 cm. long, 6–10 mm. thick, stuffed, externally firm, elastic, attenuated upwards, rarely equal, pallid, base with white down.

Among moss and grass, in pastures and woods. Northern Island, New Zealand. Europe.

Smell pleasant. Colour changing from pale-reddish through buff to white when old, but not white at first.

22. **Hygrophorus,** Fries.

Pileus fleshy, often lobed, and frequently viscid or moist; gills decurrent, adnate or adnexed, often distant and thick at the base, but margin always thin and entire; stem central; spores smooth. Entire fungus very brittle.

Hygrophorus, Fries, Syst. Myc., i., p. 98.

A very natural genus in spite of the various modes of gill attachment. The plants are often brightly coloured, very brittle, soon decaying; allied to *Cantharellus,* but differing in

the thin, sharp edge of the gills. Fries says the essential feature of the genus consists in the hymenium at length becoming soft and separating from the trama. All the species grow on the ground, usually in open grassy places. Mostly appearing late in the season, and stimulated by cold or even slight frost.

63. *Hygrophorus coccineus*, Schæffer, Fung. Bavar., tab. 302; Austr. Fung., p. 75; Sacc., Syll. v., no. 1637.

Pileus convex, then plane, often irregular, at first viscid, even, bright-crimson when moist, pallid when dry, not floccosely squamulose, margin thin, more or less wavy, 2·5–6 cm. across; flesh thin, coloured like the pileus, and also descending into the trama of the gills; gills broadly adnate, with a decurrent tooth, distant, connected by veins, soft and watery, base purplish, middle part yellow, and margin glaucous when adult; spores elliptical, smooth, $10–12 \times 6\,\mu$; stem about 5 cm. long, 6–10 mm. thick, often compressed, almost even, not slimy, crimson above, base always pale-yellow, hollow.

Among short grass, in pastures and open places. New Zealand. Australia.

Distinguished among crimson-coloured species by the broadly adnate gills and yellow base of the stem. Gills thick, wrinkled or veined; when quite dry the pileus is almost white.

64. *Hygrophorus miniatus*, Fries, Epicr., p. 330; Austr. Fung., p. 76; Sacc., Syll. v., no. 1639.

Pileus 1·5–2·5 cm. across, flesh thin, convex, obtuse, then umbilicate, at first even, glabrous, and crimson, then becoming pale, opaque, and squamulose; gills adnate, not at all decurrent, distant, distinct, rather thick and firm, yellow, or sometimes more or less tinged with crimson; stem 3–5 cm. long, about 2 mm. thick, even, glabrous, shining, crimson, equal, round, imperfectly stuffed; spores elliptical, $10 \times 6\,\mu$.

Among grass, in pastures, roads, &c. Maungaroa, New Zealand. Europe, Australia, Ceylon.

Pileus becoming umbilicate, bleached, and squamulose when old.

65. *Hygrophorus cyaneus*, Berk., Hdbk. N.Z. Fl., p. 604; Grev., vol. viii., p. 54.

Entirely clear sky-blue. Pileus acutely conical, splitting, slightly striate, 4 cm. high; gills free, very broad (1 cm.) in front, gradually narrowing to the stem; stem 12 cm. high, 7–8 mm. thick, hollow, base thickened.

Middle Island: Beech forests, amongst moss, Nelson Province. *Julius Haast.*

The present species is somewhat uncertain, being described by Berkeley from a crude drawing only.

To this species Cooke refers a drawing of a Fungus from Waitaki, with the following remark: "The colour as shown in the drawing is verdigris-green, but in other respects it does not appear to differ from the typical form in any essential particular."

23. **Pleurotus**, Fries.

Pileus fleshy, excentric, membranaceous and often resupinate in the minute species; gills decurrent, often anastomosing behind, edge entire and sharp; stem gradually widening into the pileus, excentric or lateral, sometimes absent; spores elongated.

Pleurotus, Fries, Epicr., p. 129 (as a subgenus of *Agaricus*).

Soon decaying, soft and fleshy, features which separate the present genus from others with an excentric or lateral stem. Growing on decaying wood.

* *Pileus always more than 1 cm. across*

† Pileus coloured.

66. *Pleurotus ostreatus*, Jacq., Fung. Austr., t. 268; Austr. Fung., p. 31; Sacc., Syll. v., no. 1390. *Pleurotus glandulosus*, Bull., t. 426; Sacc., Syll. v., no. 1391. *Pleurotus columbinus*, Quelét, in Bresad., Fung. Trident., p. 10, t. vi.; Sacc., Syll. v., no. 1395.

Imbricated or dimidiate. Pilei at first convex and horizontal, then expanded and ascending, flabellate or more or less oyster-shell-shaped, margin often incurved, glabrous, moist, even, but the cuticle sometimes torn into squamules, often almost black when quite young, then brownish-grey, clear blue-grey with a violet tinge, or lavender colour, often becoming yellowish when old; 6–15 cm. across; flesh thick, white, brownish just below the cuticle, up to 2 cm. thick; gills decurrent, anastomosing behind and forming a network down the under-surface of the stem, rather distant, broad, white, or tinged yellow, never pinkish; spores elliptical, white, $10–12 \times 4–5\,\mu$; stem obliterated, or short, firm, thickened near the pileus, base downy or strigose.

On trunks. New Zealand. Australia, Europe, Siberia, South Africa.

Cæspitose. Smell strong. Distinguished from every species of *Pleurotus* except *P. corticatus* by the gills anastomosing behind, and often forming a network running down the under-surface of the stem-like base. *P. corticatus* differs from the present species in having a ring on the stem. *P. glandulosus*, Bull., is the present species with the gills bearing minute glands

or warts here and there, due to the out-growth of the hyphæ of the trama. *P. columbinus*, Quelét, is the present species with the bluish-grey pileus.

Edible; celebrated from early times for its excellent flavour.

67. *Pleurotus algidus*, Fries, Syst. Myc., i., p. 190; Sacc., Syll. v., no. 1496.

Pileus rather fleshy, at first resupinate, then expanded and horizontal, reniform or semicircular, glabrous, covered with a thin viscid pellicle, reddish-brown, grey, or umber, sessile or prolonged behind into a short stem-like base; 1·5–3 cm. across; gills radiating from the point of attachment of the pileus to the matrix, rather broad, crowded, yellowish; spores sub-globose, 5–6 μ diameter.

On rotten wood, stumps, &c. Dannevirke, New Zealand. Europe, United States, Chili.

Usually cæspitose and imbricated.

68. *Pleurotus atro-cœruleus*, Fries, Epicr., p. 137; Austr. Fung., p. 35; Massee, Brit. Fung.-Flora, ii., p. 379; Sacc., Syll. v., no. 1492.

Pileus at first resupinate, sessile, soon distinctly reflexed and becoming horizontal, obovate or reniform, downy, rarely almost glabrous, rugulose when dry, due to contraction of the cuticle, usually blackish-blue, rarely brownish; 2·5–5 cm. long, up to 2·5 cm. broad; flesh soft, upper stratum (pellicle) slightly gelatinous, up to 4 mm. thick, blackish-brown; lower layer (or flesh proper) thin and whitish; gills at first radiating from a point inside the margin, then converging towards the base, broad, whitish, at length tinged with yellow; spores 7–8 × 5 μ.

On rotten trunks. Dannevirke, New Zealand. Australia, Central Africa, Europe, United States.

Sessile, gregarious, somewhat imbricated. Smell pleasant. Distinguished by the dusky colour of the pileus and by the dark-coloured gelatinous cortical layer.

69. *Pleurotus mitis*, Pers., Syn., p. 481; Austr. Fung., p. 38; Sacc., Syll. v., no. 1425.

Pileus horizontal, reniform, even, glabrous, without a viscid pellicle, whitish, or often with a more or less decided rufescent tinge, 1·5–2·5 cm. across; flesh very thin, tough, white; gills adnate and slightly decurrent, closely crowded, narrow, simple, white; spores elliptical, slightly curved, 4 × 2 μ; when young the pileus is spathulate and the stem quite distinct, truly lateral, and up to 1 cm. long, sometimes very short, compressed and broadened towards the pileus, powdered with white squamules.

On fallen branches; on coniferous trees in Europe. Dannevirke, New Zealand. Australia, Europe.

Resembling *Panus stypticus* in habit, form, and size, but differing in its white colour, glabrous pileus, and mild taste.

70. *Pleurotus salignus*, Pers., Syn., p. 478; Austr. Fung., p. 32; Sacc., Syll. v., no. 1405.

Pileus horizontal, at length depressed and strigose behind, margin entire, incurved, pale yellowish-brown or dusky, 5–10 cm. across; gills horizontal, not distinctly decurrent, 3–6 mm. broad, distinct behind, branched midway between base and front, crowded, pale, dingy, margin often broken; spores dingy, elliptic-oblong, slightly curved, 8–10 × 3·5 μ; stem always very short, firm, downy or strigose.

On rotten trunks, stumps, &c. Dannevirke, New Zealand. Australia, Europe, United States.

Not cæspitose. Readily distinguished by the pileus being pulvinate when young, then becoming depressed and strigose, gills thinner and more crowded than usual in the genus, somewhat branching, not anastomosing behind, dingy smoke-colour, as are also the spores (Fries).

†† Pileus white, dry.

71. *Pleurotus sordulentus*, Berk. and Broome, Trans. Linn. Soc., ser. ii., vol. ii., p. 54 (1883); Austr. Fung., p. 35; Sacc., Syll. v., no. 1473.

Pileus horizontal, sessile and attached by the edge or having a short stem-like point of attachment springing from the posterior of the pileus, orbicular or somewhat reniform, dingy-white, at first slightly hairy or strigose, becoming glabrous with age, margin incurved, sometimes lobed, 3–6 cm. broad; gills radiating from the point of attachment, rather broad, thin, ventricose, whitish; spores subglobose, minutely but distinctly warted, 7–8 μ diameter.

On wood. New Zealand. Queensland.

Resembling *Crepidotus mollis* in habit and general appearance, but distinguished by the persistently white gills and spores. The warted spores stamp this species.

72. *Pleurotus scabriusculus*, Berk., Linn. Soc. Journ. (Bot.), vol. xiii., p. 157; Austr. Fung., p. 35; Sacc., Syll. v., no. 1475.

Entirely white. Pileus thin, sessile, horizontal, fan-shaped or semicircular, margin usually more or less lobed, narrowed behind into a very short stem-like point of attachment which is covered with spongy down, surface of pileus (more especially behind) rough with scattered minutely projecting points, not striate, 2–5 cm. broad and about the same long (from base to

margin); gills rather narrow and crowded, radiating from the point of attachment; spores elliptical, 6–7 × 3–3·5 μ.

On logs. Dannevirke, New Zealand. Australia, Admiralty Islands.

Often more or less imbricated. I find the spores to be elliptical, 6–7 × 3–3·5 μ, in the type specimen from Australia and in Colenso's New Zealand specimens. Distinguished among the entirely white species by the scabrid or minutely rough surface of the pileus.

73. *Pleurotus bursæformis*, Berk., Fl. Tasm., ii., p. 245 (1860); Sacc., Syll. v., no. 1487; Cke., Austr. Fung., p. 35.

Pileus almost sessile or narrowed behind into a very short lateral stem-like base, horizontal or the margin drooping, very convex, flesh thin, whitish, downy behind, becoming glabrous towards the margin, 2–5 cm. across; gills slightly decurrent, transversely streaked, pallid; spores dingy-white, subglobose, 6–7 μ diameter.

On dead bark. New Zealand. Tasmania.

74. *Pleurotus guilfoylei*, Berk., Journ. Linn. Soc., v., xiii., p. 158; Austr. Fung., p. 33; Sacc., Syll. v., no. 1409.

Dimidiate or imbricated. Pileus sessile, attached laterally, horizontal, reniform, or semiorbicular, entirely white, even, glabrous, margin incurved, sometimes lobed, tomentose or downy behind near the point of attachment, 2–6 cm. across; gills rather broad and crowded, thin, margin quite entire; spores narrowly elliptical, 7–8 × 3·5 μ.

On logs, &c. Dannevirke, New Zealand. Australia.

Closely superficially resembling *Pleurotus colensoi*, Berk., but sharply distinguished by the narrowly elliptical spores, also other minor characters. A specimen of this species, now in Kew Herbarium, from Richmond River, Australia, was found growing "on the stem of a living *Areca monostachya*."

75. *Pleurotus colensoi*, Berk., in Herb.

Solitary, or more or less imbricated. Pileus sessile, horizontal, thin, entirely white, rather soft, almost or often quite even and glabrous, margin entire or slightly lobed, spreading, reniform or semicircular, 3–6 cm. broad; gills radiating from the point of attachment, rather broad and crowded, thin; spores white, smooth, subglobose, 7–8 × 6 μ.

On logs, &c. Dannevirke, Nelson, New Zealand.

Apparently a common species in New Zealand, having been sent on four different occasions by Colenso; also sent from Nelson by Dall. This species may possibly have been described somewhere by Berkeley, but I have not been able to

find the account. Distinguished by thin substance and entirely white colour.

Pleurotus guilfoylei somewhat resembles the present species, but differs in having the pileus tomentose behind and the margin persistently incurved.

76. *Pleurotus porrigens*, Pers., Obs. Myc., i., p. 54; Sacc., Syll. v., no. 1477.

Entirely white; at first orbicular and resupinate, then ascending or horizontal and becoming more or less tongue-shaped, 5–8 cm. long, 3 cm. broad, sometimes fan-shaped or almost circular, sessile, glabrous, often more or less downy near the base; flesh thin, tough; gills radiating, very narrow, rather crowded; spores broadly elliptical, $6–8 \times 4–5\ \mu$.

On stumps. Dannevirke, New Zealand. Europe.

Usually imbricated. Distinguished by the thin substance, narrow crowded gills, and white colour of every part.

77. *Pleurotus flabellatus*, Berk. and Broome, Journ. Linn. Soc. (Bot.), vol. xi., p. 928; Austr. Fung., p. 34; Sacc., Syll. v., no. 1449.

Pileus horizontal, often imbricated, thin and soft, white or more or less tinged reddish-brown, tomentose or downy, becoming glabrous, gradually narrowed behind into a somewhat slender stem-like base, and truly fan-shaped, margin sometimes irregularly lobed, 2–5 cm. long, 2–3 cm. broad; gills radiating from the narrowed base, decurrent, narrow, somewhat crowded, margin entire; spores narrowly elliptical and obliquely apiculate, $5–6 \times 3{\cdot}5\ \mu$; cystidia fusiform, apex rather acute, and rough with particles of oxalate of lime

On dead wood. Dannevirke, New Zealand. Ceylon, Australia, South Africa, Venezuela.

Distinguished from *Pleurotus colensoi* and *P. guilfoylei* by the truly fan-shaped pileus, smaller spores, and the presence of large cystidia in the hymenium, which have the projecting portion covered with particles of oxalate of lime, as in *Peniophora.*

††† Pileus white, cuticle gelatinous.

78. *Pleurotus novæ-zealandiæ*, Berk., Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 602 (as *Agaricus (Pleurotus) novæ-zealandiæ*); Sacc., Syll. v., no. 1456.

Hygrophanous, subgelatinous, white, stem obsolete but attached by a narrowed base which forms a little round disc, smooth in front, minutely scabrous behind, fan-shaped, reniform, 6–8 cm. broad, 3–4 cm. long; gills broad, distant, thin, interstices veiny.

On dead wood. Northern Island, New Zealand.

There is no specimen of this species at present in the Berkeley Herbarium at Kew, hence the original diagnosis cannot be supplemented. Berkeley says the present species is somewhat allied to *Pleurotus versiformis*, from Ceylon.

79. *Pleurotus tasmanicus*, Berk., Flor. Tasm., ii., p. 245; Austr. Fung., p. 36; Sacc., Syll. v., no. 1510.

Pileus reniform or semicircular, horizontal, even, smooth, dingy-white or pallid, invested with a gelatinous stratum, plane, or often depressed, and the margin acute and prominent, 1·5–4 cm. broad, produced behind into a very short tomentose stem-like base, or sessile; flesh 3–4 mm. thick at the base, becoming thinner towards the margin, soft, white, flesh of stem or point of attachment dingy; gills radiating from the point of attachment, rather broad, not crowded, with numerous intermediate ones, dingy-white; spores globose, 4–5 μ. diameter

On rotten wood. New Zealand. Tasmania, Australia.

Distinguished by the species having a gelatinous stratum on the pileus, and by the pallid or dirty-white colour of every part. The pileus is often depressed or concave, and the gills correspondingly convex at maturity.

80. *Pleurotus diversipes*, Berk., Flora Tasm., ii., p. 244, tab. 181, fig. 4; Austr. Fung., p. 86; Sacc., Syll. v., no. 1511.

Pileus circular or more or less excentric, pellucid, dingy-white, smooth, even, invested with a gelatinous stratum, often more or less depressed or umbilicate, horizontal owing to the upward curving of the stem, 3–5 cm across; gills rather decurrent, not very broad nor crowded, not connected by veins, whitish; spores elliptical, 5 × 3–3·5 μ; stem variable in length, up to 3 cm. long, often shorter, somewhat cartilaginous, often compressed, hollow, attached by a flattened or slightly discoid base, whitish.

On rotten logs stumps, &c. New Zealand. Tasmania, Australia.

Distinguished among species having the pileus covered with a gelatinous stratum by the hollow stem, which is sometimes almost central, at others almost lateral, but always inserted within the margin of the pileus; usually curved when the fungus grows from a vertical substratum.

** *Pileus never more than 1 cm. across.*

81. *Pleurotus cocciformis*, Berk., Flora N.Z., ii., p. 174; Hdbk. N.Z. Flora, p. 602 (as *Agaricus (Pleurotus) cocciformis*); Sacc., Syll. v., no. 1486.

Scattered, minute, 3–5 mm. across, sessile, laterally

attached, at first cup-shaped, then with the hymenium downwards; pileus covered with clusters of tawny thick-walled hairs; gills rather close together, narrow, hairy, buff.

On dead and decayed wood. Northern Island, New Zealand.

A minute and curious species; pileus densely covered with thick-walled tawny hairs arranged in fascicles; gills with the component hyphæ running out at the margin and sides into free hairs. Spores not seen. Type specimen examined.

82. *Pleurotus applicatus*, Batsch, fig. 125; Austr. Fung., p. 35; Sacc., Syll. v., no. 1504.

Pileus saucer-shaped and orbicular when young, usually sessile and fixed by the downy base, rarely furnished with a very short rudimentary stem, when adult more or less reflexed, slightly fleshy, striate when moist, minutely pruinose when young, then glabrous or downy, 4–8 mm. across; colour variable, blackish-blue, ashy-grey, or dark-grey; gills radiating from a central or excentric point, scanty, rather thick, broad, distant, grey, the margin usually whitish; spores globose, 4–5 μ diameter.

On rotten wood. New Zealand. Australia, Tasmania, Europe, Siberia, United States, Cuba, Argentine Republic, Island of Juan Fernandez.

Distinguished by the minute species, by the dingy colour of the pileus, grey gills, and by the resupinate habit, having the gills uppermost, and the pileus resting on the substratum.

83. *Pleurotus affixus*, Berk., Decad. Fung., no. 193, in Lond. Journ. Bot., 1848, p. 573; Austr. Fung., p. 34; Sacc., Syll. v., no. 1444.

Densely gregarious; minute, cup-shaped, reflexed and attached by the side, coarsely striate, membranaceous, whitish, 3 mm. broad; gills adnate, thick, ascending, arcuate, rather distant; spores elliptical, 5×3; stem very short, smooth, recurved.

On bark of standing trees, &c. New Zealand. Tasmania.

Densely gregarious; covering the bark in broad patches. Readily distinguished by its habit, form, and small size.

24. **Laccaria,** Berk. and Broome.

Pileus thin, regular; gills adnate, white, becoming mealy with the spores; stem central, externally fibrous; spores white, globose, minutely warted.

Laccaria, B. and Br., Ann. Nat. Hist., 1883, p. 370.

Allied to *Clitocybe*, under which genus the species of *Laccaria* were at one time included. Characterized by the broadly adnate gills, which become powdered at maturity

with the large white spherical warted spores. Growing on the ground.

84. *Laccaria canaliculata*, Massee. *Agaricus (Clitocybe) canaliculatus*, Cke. and Massee, Grev., vol. xviii., p. 2; Austr. Fung., p. 17. *Clitocybe canaliculata*, Sacc., Syll., suppl. ix., no. 106.

Pileus thin, dry, subglobose, then expanding, umbilicate, minutely velvety all over, fluted or channelled up to the disc, uniform bright tawny-brown, not much if at all paler when dry, margin crenulate, 1·5–3 cm. diameter; gills adnate, broad, rather distant, flesh-colour or brownish, at length mealy or pruinose with the white spores, which are globose and warted and measure 9–10 μ diameter; stem 2·5–4 cm. diameter, equal, tough, longitudinally fibrillose, paler than the pileus.

On the ground, under trees. Dannevirke, New Zealand. Queensland.

Somewhat resembling *Laccaria laccata*, Berk., but readily separated by the fluted pileus. A single specimen of this species was found mixed with another species in one of Colenso's packets (no. 670B).

85. *Laccaria laccata*, Berk., Grev., xii., p. 70; Brit. Fung.-Flora, ii., p. 443. *Agaricus (Clitocybe) laccatus*, Cke., Austr. Fung., p. 17. *Clitocybe laccata*, Sacc., Syll. v., no. 720.

Pileus thin, convex, then expanded, often more or less wavy and irregular, umbilicate, even, hygrophanous, very minutely and densely squamulose, due to the breaking-up of the cuticle, clear violet or rich brown when moist, whitish when dry, 2–6 cm. across; gills broadly adnate, distant, coloured like the pileus, at length white and mealy with the spores, thick; spores globose, warted, 8–9 μ diameter; stem 5–9 cm. long, 3–4 mm. thick, equal, fibrous, tough, coloured like the pileus, stuffed.

On the ground, in woods. Dannevirke, New Zealand. Australia, Tasmania, Asia, Africa, Europe, United States.

An exceedingly variable, at the same time very marked and distinct, fungus. In some specimens the pileus is clear violet or amethyst when moist, in others a deep rich brown; a white form has also been described. It has been proposed to raise these different coloured specimens to specific rank, but as colour is the only distinctive factor this proposal has not been generally followed. The stem and gills are always coloured like the pileus. Its distinctive features are the umbilicate pileus minutely broken up into squamules and the mealy gills.

25. **Collybia**, Fries.

Pileus regular, usually thin, margin incurved when young; gills adnexed, thin, soft; stem with a cartilaginous cortex, fistulose, often rooting, central; spores white.

Collybia, Fries, Epicr., p. 81 (as a subgenus of *Agaricus*).

Most closely allied to *Marasmius*, which, however, differs in the dry, coriaceous, tough substance of the entire plant and in resuming its shape when moistened after being dried. *Tricholoma* differs in having the stem fibrous outside, and not cartilaginous and polished. *Mycena* differs in the margin of the pileus being straight, and not incurved in the young stage. On the ground.

**Plants solitary or gregarious.*

86. *Collybia radicata*, Relh., Fl. Cant., no. 1040; Austr. Fung., p. 17; Sacc., Syll. v., no. 728.

Pileus convex, then expanded, broadly and obtusely umbonate, often somewhat irregular, glutinous, radiately rugose or wrinkled, but not distinctly and uniformly striate, brownish-olive, ochraceous-brown, sometimes with a greenish tinge, rarely altogether whitish, 3–10 cm. broad; flesh thin, soft, elastic, white; gills adnexed, narrowed behind, often with a minute decurrent tooth, at length separating more or less from the stem, ventricose, distant, rather thick, white; spores elliptical, 14–15 × 8–9 μ; stem 8–17 cm. long above ground, up to 1 cm. thick at the base, from where it becomes gradually thinner upwards, glabrous, but at length more or less longitudinally striate or grooved, the greyish-pallid cartilaginous cuticle often twisted, base fusiformly rooting, descending vertically, often as long as the above-ground portion of the stem.

In woods, &c., among grass; also in open places. New Zealand. Australia, Tasmania, South Africa, Europe, United States.

Readily distinguished by the viscid, radially rugulose pileus, and the long, tapering, polished stem, ending in an equally long, tapering, rooting base.

Collybia longipes, Bull., a species not yet met with in New Zealand, closely resembles the present species in general habit and appearance, but differs in having the pileus and stem very minutely but distinctly velvety.

87. *Collybia xanthopoda*, Fries, Epicr., p. 91; Austr. Fung., p. 20; Sacc., Syll. v., no. 836. *Agaricus (Collybia) xanthopus*, Fries, *loc. cit.*

Pileus thin, campanulate-convex, then expanded, sometimes rather wavy, umbonate, glabrous, dry, tan-colour, becoming pale, margin at length spreading and slightly

striate, 2·5–5 cm. across; gills adnexed at first, soon free, truncate behind, crowded, very broad, lax, whitish; spores elliptical, $6–7 \times 4\,\mu$; stem 6–10 cm. long, 4–6 mm. thick, tough, hollow, equal, even, glabrous, tawny-yellow; base rooting, strigose.

On the ground, in forests, &c. Dannevirke, New Zealand. Australia, Europe.

Allied to *Collybia dryophila*, but separated by the umbo, very broad gills, and strigose rooting base of the stem.

88. *Collybia nummularia*, Bull., Champ. France, t. 56; Austr. Fung., p. 20; Sacc., Syl. v., no. 839.

Pileus dry, flesh thin, soon almost plane and slightly depressed round the small umbo, even, glabrous, pallid or whitish, often variegated with red or yellow stains, 2–3·5 cm. across; gills free, broadest behind, rather distant, white; spores $4–5 \times 3\,\mu$; stem 3–6 cm. long, about 2 mm. thick, often slightly thinner downwards, pallid, stuffed, then hollow.

Among fallen leaves, in woods, &c. Dannevirke, New Zealand. Australia, Europe.

Distinguished by being altogether white or pallid, although the pileus is usually more or less stained with red or yellow, and by the pale pileus being depressed round the small obtuse umbo.

89. *Collybia dryophila*, Bull., Champ. France, t. 434; Austr. Fung., p. 20; Sacc., Syll. v., no. 871.

Pileus convex, then plane, obtuse, centre usually depressed, even, glabrous, dry, reddish-bay or pale-tan, becoming pale, but not hygrophanous, margin incurved at first, then expanded, 2·5–5 cm. across; flesh thin, white, flexible; gills almost free, with a minute decurrent tooth, but appearing as if adnexed when the pileus is depressed, crowded, narrow, distinct, plane, white or pallid; spores elliptic-fusiform, $7–8 \times 4\,\mu$; stem 2·5–5 cm. long, 2–4 mm. thick, cartilaginous, distinctly hollow, even, glabrous, somewhat rooting, base often swollen when growing in damp places among leaves, usually yellowish or rufescent.

On the ground, among fallen leaves, on rotten wood, &c. Dannevirke, New Zealand. Ceylon, India, Australia, South Africa, Europe, United States.

Solitary or loosely gregarious, inodorous, very variable. Distinguished from its nearest allies by the narrow crowded gills and the obtuse pileus. (See note under *C. xanthopoda.*)

90. *Collybia distorta*, Fries, Epicr., p. 84; Sacc., Syll. v., no. 760; Brit. Fung.-Flora, iii., p. 124.

Pileus convex, then expanded, often irregular and wavy,

umbonate, even, glabrous, bay, becoming pale, but not hygrophanous, 5–8 cm. across; flesh thin, whitish, flaccid; gills slightly adnexed, closely crowded, rather narrow, margin scarcely serrulate, white, then becoming spotted and stained with red; spores elliptical, 6–7 × 4 μ; stem 6–10 cm. long, about 1 cm. thick, becoming thinner upwards from the tomentose or downy base, twisted, sulcate or grooved, externally cartilaginous, pallid, fragile, spongy inside and soon becoming hollow.

On rotten trunks, heaps of leaves, &c. Dannevirke, New Zealand. Europe.

Collybia fusipes somewhat resembles the present species, and might be mistaken for it on a superficial examination. It is, however, quite distinct in the broad distant gills connected by veins, the distinctly fusiform rooting stem, and in being more cæspitose or tufted in habit.

** *Plants cæspitose or tufted.*

91. *Collybia velutipes*, Curtis, Flor. Lond., iv., t. 73; Austr. Fung., p. 127; Sacc., Syll. v., no. 773.

Pileus convex, then expanding until almost plane, sometimes with an indication of an umbo, smooth, even, very viscid, bright-yellow, disc tawny, or sometimes altogether yellowish-brown, 3–8 cm. across; flesh thickish at the disc, becoming very thin towards the margin, tinged yellow; gills adnexed, rather distant, ventricose, cut out behind, 4–6 mm. broad, pale opaque-yellow, margin entire; spores elliptical, 7 × 3–3·5 μ; stem 5–10 cm. long, 6–8 mm. thick, almost equal, narrowed below into a rooting base, apex yellowish, then orange-brown, becoming darker downwards, minutely velvety, stuffed.

On trunks, logs, &c. Dannevirke, New Zealand. Australia, Europe, Siberia, United States.

Readily distinguished by the bright-yellow viscid pileus and the dark minutely velvety stem. Tufted. One of the few species of the *Agaricini* capable of growing in very cold weather, and in Britain may often be seen quite vigorous after having experienced 6° of frost for several nights in succession.

92. *Collybia laccatina* (Berk.), Sacc., Syll. v., no. 807. *Agaricus (Clitocybe) laccatinus*, Berk., Journ. Linn. Soc. (Bot.), xviii., p. 383; Austr. Fung., p. 17. *Laccaria laccatina*, Berk., Grev., xii., p. 70.

Cæspitose. Pileus subglobose, then expanding until plano-convex, thin, glabrous, margin sulcate, pale fleshy-red or brownish red, 1–2 cm. across; gills adnate, distant, thick, coloured like the pileus but not such a deep tint, mealy with the spores, which are elliptical and measure 5 × 3 μ; stem

1·5–3 cm. long, 2 mm. thick, fibrillose, paler in colour than the pileus.

On dead logs, &c. Dannevirke, New Zealand. Australia.

Berkeley was mistaken in considering the present species as belonging to his genus *Laccaria*, as I have examined his type specimen, also Colenso's New Zealand specimens, both of which have elliptical spores, as described above. Cooke evidently did not examine Berkeley's specimens, but copied his mistake, and printed it in Austr. Fung, p. 17.

93. *Collybia lacerata*, Lasch, in Fries's Hym. Eur., p. 127 (1874); Cke., Hdbk. Austr. Fung., p. 21; Sacc., Syll. v., no. 918.

Pileus campanulate, rather obtuse, moist, sooty-brown, at length pale, or streaked with dark-brown on a pale ground, disc darker, about 3 cm. across; gills adnexed, distant, broad, thick, greyish-white; stem 5–10 cm. long, 4–5 mm. thick, equal, firm, twisted, fibrillosely striate, apex floccosely pruinose, at length compressed, stuffed, then hollow.

On the ground, near trunks, in pine woods, &c. New Zealand. Victoria, Europe.

94. *Collybia acervata*, Fries, Epicr., p. 92; Sacc., Syll. v., no. 869.

Pileus convex, then expanded, obtuse or at length obtusely umbonate or gibbous, pale flesh-colour when moist, whitish when dry, margin at first incurved, then expanded and slightly striate, 5–8 cm. across; flesh thin, rather flexible; gills adnexed at first, soon free, very closely crowded, narrow, plane, tinged flesh-colour, then whitish; spores elliptical, 7–8 × 3·5 μ; stem 5–10 cm. long, 2–4 mm. thick, rigid, fragile, hollow, slightly thinner upwards, rarely flattened, very glabrous except at the base, even, rufous or brown, wall of cavity of stem glabrous.

On trunks, &c. New Zealand. Europe, South Africa.

Care must be taken not to confound the present species with *Marasmius erythropus*. (See note under the last-named fungus.)

26. **Mycena**, Fries.

Pileus thin, regular, campanulate, then expanded, usually striate, margin at first straight and embracing the stem; gills adnate or adnexed, white, grey, or pinkish; stem central, slender, hollow; spores white.

Mycena, Fries, Syst. Myc., i., p. 140 (as a subgenus of *Agaricus*).

The species are as a rule small and slender; colours clear

and bright; gills often coloured, but the spores are in all cases white, and in one group the edge of the gills is coloured. Latex, white, red, or saffron, is present in some species. and escapes in drops when the fungus is broken. Allied to *Collybia*, which differs in having the margin of the pileus incurved when quite young. Most species grow on the ground; a few on wood, twigs, &c.

95. *Mycena galericulata*, Scopoli, Carn., 445; Austr. Fung., p. 23; Sacc.. Syll. v., no. 1002.

Pileus conical, then campanulate, at length expanded, thin and somewhat flexible, umbonate, dry, glabrous, rather coarsely striate up to the umbo, greyish, often with a more or less decided brown tinge, 2–5 cm. across; gills adnate, with a decurrent tooth, about 1 mm. broad, connected by veins, white, becoming tinged with pink when old or dry; spores $6–7 \times 4\ \mu$; stem variable in length, 5–10 cm., 2–5 mm. thick, equal, rigid, even, polished, pallid; base tapering and often rooting, densely strigose, hollow.

On trunks and stumps. New Zealand. Australia, Tasmania, Europe, United States.

Solitary, or more frequently tufted; sometimes growing on the ground, probably springing from buried wood.

Most closely allied to *Mycena rugosa*, a species not yet found in New Zealand. The latter, however, differs in having the pileus radially wrinkled or rugulose nearly up to the disc, but not distinctly striate; the stem is also shorter and compressed; finally, the gills are greyish-white without a trace of pink when old.

96. *Mycena epipterygia*, Scopoli, Carn., p. 453; Brit. Fung.-Flora, iii., p. 86; Sacc., Syll. v., no 1109.

Pileus membranaceous, campanulate, obtuse, becoming more or less expanded, never truly depressed, striate, covered with a pellicle that is very viscid in wet weather and easily separable in every atmospheric condition, colour variable, usually grey, or often pale yellowish-green near the margin, which is often minutely notched when young, 1–2·5 cm. across; gills adnate, with a decurrent tooth, thin, whitish or with a tinge of grey; spores elliptical, $8–10 \times 4–5\ \mu$; stem 5–10 cm. long, about 2 mm. thick, hollow, tough, often wavy, base rooting and fibrillose, even, viscid, usually yellowish but sometimes grey, pallid, or whitish.

On branches, twigs, among moss, &c. New Zealand. Europe, Siberia, United States.

Solitary or clustered. Colour variable, but readily known by the viscid pileus and stem, both being furnished with a slimy separable pellicle.

97. *Mycena filipes*, Bull., t. 230; Austr. Fung., p. 24; Sacc., Syll. v., no. 1064.

Pileus membranaceous, conical, then campanulate, at length expanded, obtuse, striate, greyish-brown or livid-grey, rarely whitish, glabrous, 1–1·5 cm. across; gills free or very slightly adnexed, narrow, ventricose, crowded, white; stem 6–10 cm. long, very slender, equal, rather fragile, flaccid, glabrous, whitish, base rooting, fibrillose, hollow.

Among fallen leaves, in damp shady places. New Zealand. Australia, Ceylon, India, Europe, United States.

Fragile. Distinguished among the small delicate species of *Mycena* by the very slender elongated stem, terminating in a long downy rooting base, which runs between the dead leaves, &c., on which the fungus grows.

98. *Mycena hiemalis*, Osbeck, in Retz., suppl. ii., p. 19; Austr. Fung., p. 26; Sacc., Syll. v., no. 1148.

Pileus very thin, campanulate, slightly umbonate, margin striate, flesh-colour, rufescent, or white, often mealy or pruinose, 4–6 mm. across; gills uncinately-adnate, narrow, whitish; spores narrowly elliptical, $7–8 \times 3·5\,\mu$; cystidia absent; stem 1·5–2·5 cm. long, slender, curved and downy near the base, whitish.

On trunks of trees, among moss and lichens. New Zealand. Australia, Europe, Central America, Cuba.

Superficially, closely resembling *Mycena corticola*, with which it sometimes grows intermixed, but separated by its more scattered habit, longer stem, and more especially by the elliptical spores and absence of cystidia in the gills.

99. *Mycena corticola*, Fries, Syst. Myc., i., p. 159; Sacc., Syll. v., no. 1147; Austr., Fung., p. 25.

Pileus very thin and delicate, hemispherical, obtuse, at length more or less umbilicate, deeply and distantly striate, glabrous, or flocculosely pruinose or mealy, 4–7 mm. across; colour very variable, blackish, bluish, brown, or grey; gills adnate, with a slight decurrent tooth, broad, somewhat ovate, pallid; spores globose, hyaline, smooth, 9–10 μ diameter; cystidia obtusely fusiform, $50–60 \times 8–10\,\mu$; stem about 1 cm. long, very slender, glabrous or minutely scurfy, paler than the pileus, incurved, minutely fistulose.

On bark of living trees, among moss and lichens. Dannevirke, New Zealand. Australia, Europe, United States.

Closely allied to *Mycena hiemalis*, but readily distinguished by the globose spores, the presence of cystidia in the broad ovate gills, and the densely gregarious habit.

27. **Tricholoma**, Fries.

Pileus regular, fleshy; gills broad, sinuate behind, margin entire, white, grey, or yellowish, often becoming spotted with rust-coloured stains; stem stout, central, fibrous throughout; spores white.

Tricholoma, Fries, Syst. Myc., i., p. 36 (as a subgenus of *Agaricus*).

All the species grow on the ground, and most are fleshy and robust. The sinuate gills mark the genus among white-spored forms.

100. *Tricholoma rutilans*, Schæffer, tab. 219; Sacc., Syll. v., no. 344.

Pileus ovato-globose, obtuse, with the margin incurved, and entirely covered with a dense unbroken coating of dark-purple or reddish-brown velvety nap, when young; when older becoming campanulate and often umbonate, purple, all one colour; at maturity expanded, often umbonate, the cuticle broken up into small purple innate fascicles of down on a yellow ground; always dry, 6–14 cm. diameter; flesh thick, soft, deep-yellow from the earliest stage, becoming golden-yellow when broken; gills broadly adnexed, yellow from the first, crowded, edge thickened, floccose, and deeper yellow than the rest of the gill; spores subglobose, 5–6 μ diameter; stem 5–9 cm. long, up to 2 cm. thick, fleshy, imperfectly hollow, soft, rather bulbous when short, ventricose when elongated, yellow, variegated, especially upwards, with purplish floccose squamules.

On the ground. New Zealand. Australia, Europe, United States.

Inodorous; size very variable. Readily distinguished by the yellow flesh and gills.

101. *Tricholoma terreum*, Schæffer, tab. 64; Sacc., Syll. v., no. 373.

Pileus campanulate, then expanded, umbonate, entirely covered with innate downy squamules, dark bluish-grey, sometimes with a tinge of brown, 5–8 cm. across; flesh soft, thick at the disc, elsewhere thin, soft; gills adnexed and cut out behind or sinuate, with a minute decurrent tooth, 4 mm. or more broad, greyish-white, margin crenulate or slightly irregular; spores subglobose, 5–6 mm. diameter; stem 2·5–7 cm. high, 1–1·5 cm. thick, almost equal, adpressedly fibrillose, whitish, stuffed.

In woods, on the ground. New Zealand. Europe.

Solitary or cæspitose, almost without smell, sometimes large and with the pileus wavy and fibrillosely squamulose,

sometimes small and regular in form; pileus papillate and also squamulosely punctate. Pileus grey, bluish, fuscous, &c.

102. *Tricholoma cartilagineum*, Bull., Champ. France, t. 589, fig. 2; Sacc., Syll. v., no. 383; Hdbk. N.Z. Flora, p. 601.

Pileus convex when young, obtuse, margin incurved and downy, then expanded and usually wavy, arched or bent down near the margin, which is persistently incurved; always very dry; flesh rather thick, rigid, white, 5–9 cm. across, densely covered with minute black granules on a white ground; gills emarginate and sinuate, crowded, thin, about 4 mm. broad, white, then grey, but not dingy; stem 2·5–5 cm. long, firm but fragile, stout, up to 2·5 cm. thick, pure white, surface even, glabrous, polished; spores globose, 7–8 μ diameter.

On the ground, in beech forests, amongst moss. Middle Island, New Zealand. Europe.

Readily distinguished by the character of the pileus, pure-white stem, and grey gills.

103. *Tricholoma brevipes*, Bull., Champ. France, t. 521, fig. 2; Sacc., Syll. v., no. 584. *Agaricus (Tricholoma) brevipes*, Hdbk. N.Z. Flora, p. 601.

Pileus convex then flattened, the umbo soon disappearing, blackish-umber or brown, becoming paler, glabrous, 3–8 cm. across; flesh thick, brownish when moist, almost white when dry; gills emarginate, crowded, ventricose, at first with a brown tinge, then whitish, 2–4 mm. broad; stem short and stout, up to 2·5 cm. long, firm, rigid, somewhat thickened at the base, 1·5 cm. thick above, solid, brown outside and inside; spores elliptical, 7 × 4 μ.

On the ground. Northern Island, New Zealand. Europe.

Distinguished by the very short more or less bulbous stem, which is solid, and brown both inside and outside.

104. *Tricholoma carneum*, Bull., Champ. France, tab. 533; Sacc., Syll. v., no. 425.

Pileus hemispherical, then convex, regular, obtuse, at length expanded and upturned, often umbonate, usually wavy, and sometimes excentric, even, glabrous, dry, not at all hygrophanous, reddish flesh-colour, at length whitish, about 2·5 cm. across; flesh thin, tough, snow-white; gills rounded behind and almost free, horizontal, closely crowded, broadest behind, 2–3 mm. broad, pure white; stem up to 2·5 cm. long, sometimes very short, 2–4 mm. thick, apex thickest, and narrowing gradually towards the base, pale reddish-pink, becoming almost white, apex somewhat pruinose, tough and fibrous, almost cartilaginous, rigid, stuffed, then hollow.

Among grass, in woods, &c. Middle Island, New Zealand. Europe.

Agreeing with the genus *Collybia* in general habit and structure of the stem, but retained in *Tricholoma* on account of its evident affinity with such species as *Tricholoma pæonium* and *T. ionides*.

28. **Armillaria**, Fries.

Pileus regular, fleshy; gills adnate or sometimes slightly decurrent; stem central, furnished with a ring; spores white.

Armillaria, Fries, Syst. Myc., i., p. 26 (as a subgenus of *Agaricus*).

All white-spored Agarics with gills touching the stem, and a ring or annulus on the stem, belong to the present genus. *Lepiota* differs in having the gills free from the stem. On branches or on the ground, round decaying stumps.

105. *Armillaria mellea*, Vahl, Flor. Dan., t. 1013; Austr. Fung., p. 11; Sacc., Syll. v., no. 289.

Pileus 5–12 cm. across, disc fleshy, remainder thin, convex then expanded, often becoming more or less depressed at the centre, often sooty or covered with olive down when young, soon paler; usually ochraceous with a tinge of honey-colour, sprinkled all over with small spreading blackish-brown scales, margin striate; gills adnate, then becoming more or less decurrent, rather distant, white with a pink tinge, then brownish and powdered with the white spores; stem 6–12 cm. long, 1–1·5 cm. thick, rigid, more or less grooved, dingy-ochraceous, floccose or almost naked below the ring, base often covered with yellowish down, stuffed, then hollow, elastic, ring near the apex; spores elliptical, $9 \times 5\text{–}6\,\mu$.

At the base of trunks or on the ground, springing from buried wood. Maungaroa, New Zealand. Europe, North America, South America, Australia, India.

Usually densely tufted, although sometimes solitary, and then usually larger; very variable; stem and pileus often quite glabrous, especially when old. A very destructive parasite to timber trees in Europe, the black cord-like strands of mycelium running between the wood and the bark, also travelling in the ground from one tree to another. These strands of mycelium were at one time considered as constituting a distinct genus of Fungi called *Rhizomorpha*.

29. **Lepiota**, Fries.

Pileus regular, usually scaly; gills free from the stem, white or tinted; stem central, bearing a ring; spores white or dingy.

Lepiota, Fries, Syst. Myc., i., p. 19 (as a subgenus of *Agaricus*).

Free gills and a ring on the stem are the important features of the present genus. In some species the ring disappears soon after the pileus expands. On the ground.

106. *Lepiota exstrucata*, Berk., Flora N.Z., ii., p. 173; Hdbk. N.Z. Flora, p. 601 (as *Agaricus (Lepiota) exstrucatus*); Sacc., Syll. v., no. 197.

Pileus rather fleshy, campanulate, then expanding, white, surface broken up into warts or concentrically arranged, more or less overlapping, thick scales, white, 2·5–3·5 cm. high, 4–6 cm. broad when expanded; gills very distant from the stem, rather crowded and narrow, white with a tinge of pink; spores hyaline, broadly elliptical, ends very obtuse, smooth, 14-15 × 10 μ; stem 7–10 cm. high, slightly thickened at the base, pallid, ring ample, superior.

In meadows, &c. Bay of Islands, Auckland, New Zealand.

A very beautiful endemic species. Examination of Berkeley's type specimen, supplemented by others accompanied by notes and sketches, has enabled me to complete the description. Belongs to the *procerus* group, and is in all probability edible.

107. *Lepiota clypeolaria*, Bull., Champ. France, t. 405, f. 2 (as *Agaricus*); Flora N.Z., ii., p. 173; Hdbk. N.Z. Flora, p. 601; Austr. Fung., p. 6; Sacc., Syl. v., no. 101.

Pileus at first obtusely cylindrical, even, apex tawny, surface silky and soft but not at all broken up, then campanulately expanded, umbo tawny. the remainder entirely broken up into very soft tan-coloured small scales concentrically arranged, 4–7 cm. across; flesh thickish, soft, white; gills free but close to the stem, up to 5 mm. broad, soft, crowded, white or tinged yellow; spores elliptical, 6 × 4 μ; stem about 8 cm. long, 5–6 mm. thick, soft, fragile, equal or slightly thickened at the base, at first with spreading scales from the breaking-up of the yellowish veil, becoming almost naked, pallid, and fibrillose, striate above the ring, stuffed, then hollow.

On the ground, in woods, &c. Northern Island, New Zealand. Europe, United States.

Characterized by the gills being close to the stem, the concentrically squamulose pileus, and scaly stem. Its nearest ally, *L. cristata*, is not yet recorded for New Zealand. The pileus is variable in colour, white, pink, rufous, brown, &c.

108. *Lepiota mesomorpha*, Bull., Champ. France, tab. 506, fig. 1; Austr. Fung., p. 9; Sacc., Syll. v., no. 165.

Pileus thin, campanulate, then expanded, the margin sometimes slightly turned up, often more or less umbonate, dry, even, glabrous, yellowish, or pale yellow-brown, about 2 cm.

across; gills free, about 1 line broad, ventricose, clear white; spores elliptical, 5–6 × 3 μ; stem 2·5–3·5 cm. long, about 2 mm. thick, equal, dry, even, glabrous, paler than the pileus, fistulose; ring superior, persistent, erect, whitish.

On the ground. New Zealand. Australia, Europe.

Readily distinguished by the even and glabrous pileus and stem—very exceptional features in *Lepiota*—and the entire, erect, persistent ring.

30. **Amanita**, Fries.

Entire fungus at first enclosed in a universal veil which is ruptured during growth, one portion remaining as a volva or sheath at the base of the stem, the remainder forming separable patches or warts on the pileus; gills free, white; stem central, bearing a ring; spores white.

Amanita, Fries, Syst. Myc., i., p. 12 (as a subgenus of *Agaricus*).

Gills free, stem with a volva and ring, are the essentials constituting the genus *Amanita*. *Lepiota* differs in the absence of a volva sheathing the base of the stem. All grow on the ground.

109. *Amanita phalloides*, Fries, Syst. Myc., i., p. 13; Flora N.Z., ii., p 173; Hdbk. N.Z. Flora, p. 601; Sacc., Syll. v., no. 7.

Pileus ovate, then campanulate, finally expanded, obtuse, covered with a pellicle that is viscid when moist but not glutinous, rarely with one or more patches of the volva attached, margin regular, even, colour very variable, usually white or pale-yellow when exposed to light, greenish or with an olive tinge or often spotted when in the shade; flesh rather thick, white; 7–11 cm. across; gills free, ventricose, 6–8 mm. broad, pure white; stem 8–12 cm. long, 1·5–2 cm. thick, almost glabrous, white bulbous, solid at the base, hollow and slightly narrowed upwards, often curved; ring superior, large, reflexed, slightly striate, tumid, usually entire, white; volva more or less buried in the ground, nearly free, lateral margin irregular; spores subglobose, 7–8 μ diameter.

In woods. Northern Island, New Zealand. Europe, Australia, United States.

Distinguished by the large nearly free volva and ample ring. Smell not strong, but unpleasant. Very poisonous. The majority of cases of poisoning caused by Fungi in Europe are due to partaking of this species for food.

Amanita mappa, a species superficially much resembling *A. phalloides*, is distinguished from the latter by the volva being adnate to the base of the stem, except a narrow free entire margin. Poisonous.

110. *Amanita mappa*, Fries., Epicr, p. 4 (1836); Sacc., Syll. v., no. 8; Cke., Habk. Austr. Fung., p. 2.

Pileus 6–10 cm. across, rather fleshy, convex, then almost plane, dry, pale-yellow, sometimes whitish or with a tinge of green, with a few irregular patches of the volva adhering; gills slightly adnexed, rather narrow, crowded, white; stem 5–8 cm. long, smooth, white, equal, globosely bulbous at the base; ring superior, soft, usually more or less torn; volva splitting in a circumscissile manner, connate with tho base of the stem, free margin narrow; spores subglobose, 7–9 μ diameter.

On the ground. North Island. Europe, North America.

Smell strong, colour variable. A very poisonous fungus. Allied to *Amanita phalloides;* differing in the shorter equal stem and narrow free margin of the volva.

31. **Xerotus**, Fries.

Pileus dry, tough, thin; gills slightly decurrent, coriaceous, narrow, often forked, margin entire, rather blunt or thickened; stem central or excentric; spores white.

Xerotus, Fries, Epicr., p. 48.

Resembling *Cantharellus* in the thick margin of the gills, but differing in the thin tough or coriaceous consistence of every part of the fungus. Most of the species become blackish when dried. Growing on wood, twigs, &c.

111. *Xerotus glaucophyllus*, Cke. and Massee, Grev., vol. xx., p. 120; Sacc., Syll., suppl. xi., no. 269.

Pileus sessile, very thin, horizontal, fan-shaped or irregularly circular in outline, margin sometimes slightly lobed, attached laterally, glabrous, more or less fluted, extreme edge often upturned, dusky (when dry), 1·5–2·5 cm. across; gills few, distant, broad, with shorter intermediate ones radiating from the point of attachment, pale brick-red, then becoming glaucous with the white globose spores, which are about 6 μ diameter.

On slender twigs. New Zealand.

Distinguished by the broad gills and the extreme margin of the pileus upturned, at least when dry. The species of *Xerotus* are remarkable for becoming dingy in colour and, in many instances, black when dry.

111A. *Xerotus drummondi*, Berk., MS.; Austr. Fung., p. 100.

Gregarious. Pileus horizontal, laterally attached by a thickened stem-like point but sessile, reniform, or almost circular, very thin, flexible when dry, glabrous or minutely cracked under a lens, rust-colour or dark-red, almost even,

margin often more or less lobed, the extreme edge drooping and held down by the gills, about 1 cm. across; gills distant, radiating from the persistently pale thickened point of attachment of the fungus to its support, rather distant, broadest in front, not usually connected by veins, becoming blackish; spores dingy, subglobose, 4–5 μ diameter.

On small twigs and branches. New Zealand. Australia.

In some of Drummond's specimens the pretty cockle-shell-shaped pilei are crowded on the branches. There are fine specimens from New Zealand in Berkeley's herbarium. Distinguished by the reddish pileus and very thin flexible flesh.

32. **Marasmius**, Fries.

Pileus regular, thin, tough and pliant; gills pliant, somewhat distant, variously attached or quite free, edge thin, entire, often connected by transverse bars or veins; stem central, slender, cartilaginous or hoary, minutely velvety or polished; spores white.

Marasmius, Fries, Epicr , p. 372.

A very distinct genus, but distinguished more especially by biological characters. Differing from *Collybia* and *Mycena*, its nearest allies, by not deliquescing at maturity, but drying up, and again assuming the original form when moistened. Many species have a smell resembling garlic. On the ground, among dead leaves, some on branches, &c.

112. *Marasmius erythropus*, Fries, Epicr., p. 378; Austr. Fung., p. 83; Sacc., Syll. v., no. 2051.

Pileus convex, then plane, glabrous, obtuse, hygrophanous, pallid, disc darker, wrinkled or rugulose and almost white when dry, about 2·5 cm. across; flesh thin, rather flexible; gills almost free, broad, distant, soft and elastic, connected by veins, whitish, margin quite entire; spores 8–10 $\times$ 5–6 μ; stem 5–10 cm. long, about 4 mm. thick, hollow, firm, tough, round or becoming flattened more or less, blackish-red, glabrous upwards and paler at first, rather pruinose when dry, furnished with white strigose down near the base, inside wall of the hollow stem downy.

In woods, among fallen leaves; rarely on trunks. New Zealand. Australia, Europe, United States.

Scattered or in small clusters. Rather closely resembling *Collybia acervata*, but distinguished by the broad distant gills.

113. *Marasmius caperatus*, Berk., Flora N.Z., ii., p. 175; Hdbk. N.Z. Flora, p. 605.

Entirely snow-white; pileus membranaceous, wrinkled

and corrugated, smooth, 2–3 cm. across; gills distant, adnate, rather broad, connected by prominent ribs; spores elliptical, $5 \times 3 \mu$; stem up to 1 cm. long, slender, furfuraceous.

On dead wood. Wairarapa, Northern Island, New Zealand. Himalayas.

Distinguished by the membranaceous substance, pure-white colour, and the prominent ribs on the inside of the pileus connecting the gills. Tough. Type specimen examined.

114. *Marasmius impudicus*, Fries, Epicr., p. 277; Austr. Fung., p. 84; Sacc., Syll. v., no. 2057.

Smell strong and very unpleasant; pileus convex, then plane, the centre often depressed, reddish-bay, pale when dry, 1·5–2·5 cm. across when expanded; flesh thin, soft and pliant, membranaceous from the margin half-way up and coarsely striate; gills at first slightly adnexed, but becoming free during the expansion of the pileus, connected by veins, ventricose, at first crowded then distant, white with just a suspicion of pink; spores elliptical, 8×4–5μ; stem 3–5 cm. long, 2 mm. thick, equal, slightly wavy or flexuous, tough, rufous or rufous-brown or sometimes purple-violet, naked, but entirely covered with delicate white down when dry, base narrowed and rooting.

On or about rotten trunks and stumps, especially pine. New Zealand. Australia, Europe.

Gregarious. Agreeing with *Marasmius fœtidus* and *M. perforans* in the strong fœtid smell. The last two named, however, differ from the present in having the stem minutely but distinctly velvety.

115. *Marasmius vaillantii*, Fries, Epicr., p. 330; Sacc., Syll. v., no. 2072.

Pileus thin, pliant, at first convex, soon flattened and more or less depressed at the disc, marked with radiating ridges, whitish, 1·5–2·5 cm. across when expanded; gills adnate, but from their triangular form appearing somewhat decurrent, broad, distant, distinct, simple, white; spores elliptical, $10 \times 6 \mu$; stem about 2·5 cm. long, thickened upwards, glabrous, bay, shining, apex paler, base blackish, naked, penetrating the substance upon which it is growing.

On dead wood, fallen twigs, leaves, &c. Dannevirke, New Zealand. Europe, United States.

Inodorous. Small, tough, dry. *Marasmius impudicus* differs in the purplish stem becoming covered with white velvety down when dry.

116. *Marasmius hæmatocephalus*, Montag., Syll. Crypt., no. 351 (1856); Sacc., Syll. v., no. 2143.

Pileus very thin, campanulate, then convex, finally almost plane, plicate, margin crenate, glabrous, deep-red, up to 1 cm. across; gills narrowly adnexed, distant, pallid; stem 3–5 cm. long, very slender, equal, horny, umber or blackish, expanded at the base into a minute pallid disc.

On fallen leaves, wood, &c. New Zealand. Victoria, Ceylon, Surinam, Brazil, Guiana, Cuba, United States.

Readily distinguished by the deep-red colour of the plicate or fluted pileus, and the dark hair-like stem.

117. *Marasmius insititius*, Fries, Epicr., p. 386; Sacc., Syll. v., no. 2231.

Pileus membranaceous, pliant, convex, then plane, often slightly umbilicate, not polished, at length coarsely grooved or plicate, pale yellowish-brown, becoming whitish, 1–1·5 cm. across; gills broadly adnate, becoming narrower in front, distant, simple, unequal, pallid, then white; spores $4 \times 2{\cdot}5\,\mu$; stem 2–3 cm. long, thin, equal, horny, minutely floccose or scurfy, fistulose, slightly attenuated at the base and abruptly piercing the matrix, coloured like the pileus, or sometimes whitish.

On dead fallen leaves and twigs. Dannevirke, New Zealand. Europe, United States.

Distinguished from allies by the coarsely grooved pileus and scurfy stem.

118. *Marasmius subsupinus*, Berk., Flora Tasm., ii., p. 249; Austr. Fung., p. 88; Sacc., Syll. v., no. 2260.

Pileus almost membranaceous, convex, erect at first, then frequently upturned with the gills uppermost, rather wrinkled, mealy, whitish, or tinged brown, 0·5–1 cm. diameter; gills adnexed, rather broad, few in number, rather thick and rigid, plane, not connected by veins; spores pip-shaped, $7 \times 4\,\mu$; stem 2–3 mm. long, slender, mealy.

On dead stems of *Rhipogonum*. Pohangina River, New Zealand. Tasmania, Australia.

Sometimes growing horizontally with the pileus uppermost, and standing out from the matrix like one valve of a tiny bivalve shell. Gregarious.

119. *Marasmius inversus*, Massee, sp. nov.

Gregarious or scattered. Pileus membranaceous, dry, reniform or almost circular, brownish or dingy-ochraceous, almost even and glabrous, usually inverted, so that the gills are

uppermost and the pileus in contact with the substratum, 3–6 mm. across; gills adnate, distant, rather broad, sometimes forked, shorter intermediate ones present, scarcely or not at all connected by veins, pale yellowish-buff when dry; spores elliptical, 6–7 × 4 μ; stem lateral or nearly so, short, slender, coloured like the pileus, arched and standing above the pileus when the latter is inverted.

On slender branches and twigs, lying on the ground. New Zealand.

A minute but very interesting species, sent to Kew by Colenso (no. b, 563), and was at the time referred to *Marasmius spaniophyllus*, Berk., from which species it is indeed truly distinct. The last-named species must therefore be removed from the list of New Zealand Fungi. Readily distinguished by its small size and peculiar inverted habit of growth.

33. **Panus,** Fries.

Entirely coriaceous, tough, drying up. Pileus irregular, stipitate, sessile, horizontal or resupinate; gills more or less decurrent, margin thin, quite entire; stem excentric, lateral, or entirely absent; spores white.

Panus, Fries, Epicr., p. 396.

Allied to *Lentinus* in the tough coriaceous substance, but at once distinguished by the gills having the margin or edge quite entire. On wood.

120. *Panus maculatus*, Berk., Flora N.Z., p. 176; Hdbk. N.Z. Flora, p. 606; Sacc., Syll. v., no. 2577.

Closely imbricated or overlapping. Pilei reniform, convex, at first innato-tomentose, the cuticle cracking up into shortly reflexed scales, at length quite smooth; margin slightly involute; stems connate, scarcely visible except in young pilei; gills rather distant, decurrent, broad, wavy when dry, margin quite entire; spores hyaline, oblong, about 8 μ long.

On dead trunks. Northern Island, New Zealand.

The scales arise from the cracking of the cuticle, in consequence of which a slight portion is reflected in front, while that behind is not at all disturbed. Ample. (Berk.)

121. *Panus incandescens*, Berk. and Broome, Trans. Linn. Soc., ser. ii., vol. ii., p. 55; Austr. Fung., p. 96; Sacc., Syll. v., no. 2451.

Entirely whitish or dingy; pileus varying from umbilicate to deeply funnel-shaped, glabrous, but very minutely wrinkled or virgate, margin persistently incurved, 4–10 cm. across, often very irregular in form; flesh thick at the disc, whitish, tough;

gills deeply decurrent and running as very fine lines almost to the base of the stem, thin, narrow, rather crowded; spores $7 \times 4\,\mu$; stem 2–4 cm. high, up to 8 mm. thick, slightly narrowed downwards.

On logs, or on the ground, springing from buried wood. New Zealand. Australia.

Remarkable for being very luminous at night. Tufted and often irregular; variable in size.

122. *Panus tahitensis*, Reichardt, Novara Exped., p. 142; Sacc., Syll. v., no. 2555.

Pileus reniform, plano-convex, quite glabrous, margin quite entire, incurved, base depressed, whitish, then tan-colour, coriaceous and tough, 6–7 cm. broad; gills not decurrent, firm, crowded, ochraceous-white, then becoming brownish; spores elliptical, hyaline, smooth, 6–7 μ long; stem distinctly lateral, very short, scarcely 2 mm. long.

On rotten trunks, in woods. Dannevirke, New Zealand. Island of Tahiti.

123. *Panus stipticus*, Fries, Epicr., p. 399; Flora N.Z., ii., p. 176; Hdbk. N.Z. Flora, p. 605; Massee, Brit. Fung.-Flora, ii., p. 309; Austr. Fung., p. 97; Sacc., Syll. v., no. 2557.

Imbricated, fixed laterally, horizontal, thin, flexible, reniform, margin usually entire, cuticle broken up into minute scurfy scales, cinnamon, then yellowish-buff, 1·5–3 cm. across; gills rather crowded and narrow, connected by thin transverse ridges, margin entire; spores hyaline, $3 \times 2\,\mu$; stem distinctly lateral, compressed, very short. Taste hot and pungent.

On decaying trunks, stumps, &c. Northern Island, New Zealand. Australia, Europe, United States.

Recognised by the densely crowded imbricated habit, cinnamon-colour of every part, and the hot taste.

34. **Lentinus**, Fries.

Pileus coriaceous, tough, hard and dry when old; gills dry, tough, thin, margin thin, minutely toothed or eroded, more or less decurrent; stem central, excentric, or lateral; spores white.

Lentinus, Fries, Epicr., p. 45.

Allied to *Panus*, but readily distinguished from this and every other genus of dry coriaceous species by having the margin of the gills minutely toothed or notched. Always on wood, branches, &c.

124. *Lentinus novæ-zelandiæ*, Berk., Flora N.Z., ii., p. 176; Hdbk. N.Z. Flora, p. 605; Sacc., Syll. v., no. 2481.

Sessile, attached by a narrowed base, fan-shaped, reniform or suborbicular, thin and flexible, bay-brown, clothed behind with short velvety olive down, about 2·5 cm. long and broad; gills decurrent behind, narrow, edge thin and torn, coloured like the pileus.

On dead wood. New Zealand.

Closely resembling *Lentinus castoreus*, but smaller, and with narrower gills. There is no specimen in Berkeley's herbarium.

125. *Lentinus castoreus*, Fries, Epicr., p. 305; Austr. Fung., p. 95; Sacc., Syll. v., no. 2485.

Imbricated, sessile but narrowed behind into a more or less pronounced stem-like base, the component pilei narrowly fan-shaped or tongue-shaped, margin narrowly incurved, entire or wavy; sometimes the pelei are resupinate, margin free all round, and the gills radiating from the centre, at others curled to form a funnel-shaped pileus, flexible, even or wrinkled, rufous, then yellowish-tawny, 3–12 cm. long; gills crowded, rather narrow, margin irregular, brownish; spores hyaline, subglobose, 4 μ.

On logs, &c. Northern Island, New Zealand. Europe, Cuba, United States.

Very variable in form and size. The principal distinctive features are the elongated pilei, tan colour, and glabrous pileus. The figure of this species by Fries (Icones, pl. 175, f. 3) is 14 cm. broad and the gills 1 cm. broad; it is, however, usually smaller.

126. *Lentinus hepatotrichus*, Berk., Flor. Tasm., p. 249, pl. clxxxi., fig. 9 (1860); Cke., Austr. Fung., p. 95; Sacc., Syll. v., no. 2490.

Pileus sessile, attached laterally, hoof-shaped. horizontal, 1·5–2 cm. broad, somewhat shaggy or strigose at the point of attachment, becoming smooth towards the margin, liver-colour or sometimes yellowish; gills radiating from the point of attachment, broad, rather distant, pallid, margin minutely toothed; spores elliptical, smooth, pallid, $7 \times 5\,\mu$.

On wood and bark. New Zealand. Tasmania.

Distinguished by the dark colour of the pileus and the broad gills having the margin minutely crenulated.

127. *Lentinus lepideus*, Fries, Epicr., p. 390; Austr. Fung., p. 91; Sacc., Syll. v., no. 2351.

Pileus fleshy, tough, convex, then depressed and unequal, pale dingy-ochraceous, becoming broken up into darker spot-

like squamules, 4–8 cm. across; flesh 4–6 mm. thick at the disc, white; gills decurrent, slightly sinuate, 4–6 mm. broad, margin irregular, torn, transversely striate, whitish or tinged with yellow; spores narrowly elliptical, smooth, $7 \times 3 \mu$; stem usually 2–3 cm. long but sometimes longer, about 1 cm. thick, tapering below into a rooting base, hard, pale, with downy squamules, the veil soon disappearing.

On logs, stumps, &c. Dannevirke, New Zealand. Australia, Europe, Siberia, United States.

Showy, large, firm, much deformed, often somewhat excentric; smell pleasant. Often white. Developing into very grotesque forms when growing in dark situations.

128. *Lentinus zealandicus*, Sacc., Syll. v., no. 2467. *Scleroma pygmæum*, Berk., Flora N.Z., ii., p. 176; Hdbk. N.Z. Flora, p. 605.

Pileus thin, rather tough, cream-colour or dingy-white, glabrous, slightly striate, deeply umbilicate or funnel-shaped, 1·5–2·5 cm. across; gills decurrent, rather distant and broad, edge quite entire, interstices even; spores pip-shaped, hyaline, $6 \times 4 \mu$; stem 2·5–5 cm. long, very slender, with a tawny or rufescent tinge, base with pale down, rooting.

On rotten logs. Forest of Tehawera, Northern Island, New Zealand.

Solitary, or frequently 2–5 plants springing in a cæspitose manner. Rigid when dry. Not a typical *Lentinus*, on account of the entire edge of the gills.

35. **Lenzites**, Fries.

Pileus corky, coriaceous, growing horizontally, sessile and attached by a broad base behind; gills coriaceous, elastic, radiating from the point of attachment of the pileus, edge sharp, entire; spores white.

Lenzites, Fries, Epicr., p. 403.

Allied to *Trametes* and *Dædalea*, but differs in the gills remaining free from each other, and not anastomosing or connected by transverse bars to form elongated pores. *Lentinus* differs in the serrated margin of the gills. Growing on wood.

129. *Lenzites repanda*, Fries, Epicr., p. 404; Flora N.Z., ii., p. 177; Hdbk. N.Z. Flora, p. 606; Sacc., Syll. v., no. 2688; Austr. Fung., p. 103.

Pileus attached laterally, horizontal, thin, sessile but contracted at the point of attachment into a very short thickened stem-like base, irregularly reniform, margin often lobed or wavy, almost plane, glabrous, with raised concentric zones,

pallid or whitish, 6–15 cm. broad, entire texture corky; gills radiating from the point of attachment, forking, narrow, often anastomosing laterally to form sinuous pits of various lengths, closely crowded, coloured like the pileus; spores hyaline, elliptical, 5 × 3 μ.

On dead wood. Northern Island, New Zealand. Australia, Borneo, Ceylon, Himalayas, China, Andaman Islands, Mauritius, West Africa, West Indies, United States. Absent from Europe.

A beautiful and widely distributed species, closely resembling *Lenzites deplanata*, Fries, and *L. applanata*, Fries, differing from both in the pileus being glabrous and marked with raised concentric zones or ridges. The corky gills are narrow and very closely crowded, and anastomose to such an extent that the hymenium consists of more or less elongated pits, as in *Dædalea*, rather than of gills. The present genus connects the *Agaricineæ* with the *Polyporeæ*. The corky substance is that of the latter.

130. *Lenzites betulina*, Fries, Epicr., p. 405; Austr. Fung., p. 101; Sacc., Syll. v., no. 2630.

Pileus horizontal, sessile, attached behind by an expanded base, more or less reniform or semicircular, tomentose or minutely velvety, pallid, slightly zoned, tinged brownish, becoming pale, margin similar in colour, 5–12 cm. long, 2·5–6 cm. broad; flesh up to 8 mm. thick behind, becoming gradually thinner up to the acute straight margin, corky and elastic, white; gills rather thin, radiating from the point of attachment of the fungus, broad, forked and anastomosing, straight, dingy-white; spores elliptical, smooth, 4 × 2 μ.

On trunks, stumps, &c. Dannevirke, New Zealand. Australia, Europe, Siberia, United States.

When young the gills are thickish, somewhat joined together here and there, resembling pores; at a later stage of development they become thin, with a thin sharp edge. Imbricated as a rule. Entire fungus corky and tough, firm and rigid, usually indistinctly zoned.

EXPLANATION OF PLATES XXII.–XXIV.

Plate XXII.

[*These diagrams illustrate the principal types of structure used in describing Agarics.*]

Fig. 1. Section showing an *infundibuliform* or funnel-shaped pileus, *a*, and *decurrent* gills, *b*. The stem is hollow.

Fig. 2. Section showing an *umbilicate* pileus, *a*, and *adnate* gills, *b*. The margin or edge of the pileus is *involute* or incurved, *c*.

PLATE XXII.—*continued.*

Fig. 3. Section showing a fungus having the margin of the pileus straight and adpressed to the stem when young, *a.*

Fig. 4. A young plant enclosed in a *universal volva*, *a*, which is becoming ruptured and exposing the young fungus, *b.*

Fig. 5. Section of a young plant enclosed in a *universal volva*, *a*, which is yet entire.

Fig. 6. Fungus furnished with a *volva*, *a*; portions of the volva remaining as patches on the pileus, *b*; *annulus* or ring on the stem, *c.*

Fig. 7. A *resupinate* fungus with *excentric* gills.

Fig. 8. Section showing *umbonate* pileus, *a*, and *adnexed* gills, *b.*

Fig. 9. Section showing *gibbous* pileus, *a*, and *sinuate* gills, *b.*

Fig. 10. Section of a *dimidiate* pileus growing on wood, *a.*

Fig. 11. Section showing *free* gills, *a.*

Fig. 12. A fungus showing the *secondary veil*, *a*, breaking away from the margin of the pileus, and exposing the gills.

PLATE XXIII.

Fig. 1. *Amanita phalloides*, Fries; natural size.

Fig. 2. Section through portion of pileus and stem of same; natural size.

Fig. 3. Basidium and spores of same; × 400.

Fig. 4. *Lepiota clypeolaria*, Bull.; natural size.

Fig. 5. Section through portion of pileus and stem of same; natural size.

PLATE XXIV.

Fig. 1. *Pluteus cervinus*, Schæff.; natural size.

Fig. 2. Section of portion of pileus of same; natural size.

Fig. 3. Portion of hymenium, showing a single basidium bearing four spores, two paraphyses, and one cystidium; × 400.

Fig. 4. *Pholiota præcox*, Pers.; natural size.

Fig. 5. Section of portion of pileus and stem of same; natural size.

Fig. 6. Basidium with four spores, one large cystidium, and paraphyses of same; × 400.

Fig. 7. *Psathyrella disseminata*, Pers.; natural size.

Fig. 8. Section of same; natural size.

Fig. 9. Spores of same; × 400.

Fig. 10. *Omphalia colensoi*, Berk.; natural size.

Fig. 11. Section of same; natural size.

Fig. 12. Basidium and spores of same; × 400.

Fig. 13. *Xerotus glaucophyllus*, Cke. and Mass.; natural size.

Art. XXIX.—*On the Occurrence of* Ottelia *in New Zealand.*

By T. F. Cheeseman, F.L.S., F.Z.S.

[*Read before the Auckland Institute, 10th October, 1898.*]

Rather more than a year ago I had occasion to visit the three little volcanic hills at Ihumatao, which unite to form the promontory jutting out into the Manukau Harbour to the south of Weekes Island. Taking a short cut from one of these hills to regain the road to Mangare and Onehunga, my attention was attracted by the large yellowish-white flowers of a water-plant which quite covered the surface of a small pond, and which was evidently a stranger to me. On examination it proved to be *Ottelia ovalifolia*, a species which is not uncommon on the eastern side of Australia, ranging from Victoria to the North of Queensland, but which had not been previously noticed in New Zealand. Curiously enough, it belongs to the same order—*Hydrocharidaceæ*—as *Vallisneria spiralis*, which a few years ago appeared in Lake Takapuna, and has since become extremely plentiful there (see Trans. N.Z. Inst., 1896, p. 386). *Ottelia*, however, is very dissimilar in appearance to *Vallisneria*. The leaves, which are numerous and densely tufted, are borne on stout cylindrical petioles, varying in length in accordance with the depth of the water. These petioles are greatly swollen at the base, forming a mass of air-cells. The blade of the leaf is about oval in shape, and from 2 in. to 3 in. in length, and lies flat on the surface of the water. The flower-stalks rise just above the surface of the water, each one bearing a single rather large yellowish-white flower. The flowers are produced in profusion during the whole of the summer months, giving the plant a very attractive appearance.

No doubt *Ottelia* has been introduced from Australia, but whether purposely or by accident I am unable to say. The locality is a remarkable one for a naturalised plant to make its first appearance, and the few settlers residing in the vicinity have no information to give as to its establishment, beyond the fact that it has existed in the pond for many years past. So far as I am aware, the plant has never been in cultivation in Auckland, either in private gardens or in nurseries. It is certainly not usually cultivated in Australia, and its name does not appear in any of the nurserymen's lists. As the pond is an isolated one, the plant is not likely to spread further; but if by chance it should be conveyed to any of the

lakes or slow-running streams in the northern portion of the colony it may be expected to show a rapid increase.

While on the subject of water-weeds, I may mention that there is some risk of the establishment in the northern portion of the colony of the water-hyacinth (*Eichornia crassipes*), a plant of very similar habit to *Ottelia*, although in reality belonging to a very different order. It is now commonly cultivated in ponds or small tanks, and apparently does well in our climate. Its naturalisation ought to be guarded against, for in Florida, where it was introduced some years since, it has increased to such an enormous extent as to completely block the navigation of several of the more sluggish rivers.

ART. XXX.—*Description of a New Species of* Corysanthes.

By T. F. CHEESEMAN, F.L.S., F.Z.S.

[*Read before the Auckland Institute, 10th October, 1898.*]

Corysanthes matthewsii, n. sp.

A very delicate little plant, barely more than 1 in. in height, including the flower. Leaf ½ in.–1 in. in length, solitary, membranous, broadly ovate-cordate or orbicular-cordate, sessile, subacute or obtuse, when dry showing one or two veins on each side of the midrib connected by transverse veinlets. Flower solitary, shortly peduncled, about ½ in. in length, drooping, purplish-green. Bract small, erect. Upper sepal very narrow at the base, widened towards the tip and arched forwards, so as to become hood-shaped, obtuse. Lateral sepals and petals very small, narrow linear-subulate, barely more than one-half the length of the lip. Lip large, involute, the lateral margins meeting behind the column and enclosing it, orbicular-cordate or slightly three-lobed when spread out, veined; apex truncate, produced downwards, entire or very slightly fringed. Column short, stout, curved. Fully ripe capsules not seen.

Hab. Vicinity of Kaitaia, Mongonui County: *Mr. R. H. Matthews.*

I have pleasure in dedicating this pretty little plant to its discoverer, to whom I am indebted for much interesting information respecting the botany of his district. It agrees with *Corysanthes cheesemanii*, Hook. f., in the lateral sepals and petals being much reduced in size, but differs altogether in the shape of the lip, which is not recurved at the apex, nor produced at the base into the two curious spurs of

C. cheesemanii. The upper sepal is also much narrower. Except for the great difference in the size of the lateral sepals and petals the structure of the flower is much nearer that of *C. oblonga.* But the flowers are larger than in that species, the lip is not coarsely fringed at the apex, and the upper sepal is narrower at the base and much more hood-shaped at the tip.

Art. XXXI.—*Botanical Notes.*

By D. Petrie, M.A.

[*Read before the Auckland Institute, 10th October, 1898.*]

Plates XXV.-XXVII.

1. **Ranunculus kirkii,** Petrie. Plate XXV.

This plant seems to have escaped notice since I gathered it a good many years ago on the low lands skirting the head of Paterson's Inlet. As it is still so imperfectly known, I think it desirable to submit for publication the accompanying drawing of it, which was kindly executed for me at the time of its discovery by the late Mr. John Buchanan, F.L.S. The specimen here depicted is now in the Herbarium at Kew. The habit of the plant as here shown is not quite characteristic, but the material at the artist's disposal was too limited to allow of his recognising this. The scapes elongate considerably after flowering. I transcribe the following report on it by Mr. N. E. Brown, one of the botanists on the staff at Kew:—

"No. 50. *Ranunculus kirkii,* Petrie.—Nothing like this at Kew from the Southern Hemisphere. It is near *R. acaulis* and *R. biternatus,* but differs from both by its thick roots, leaves, and fruits, and from *R. trilobatus,* Kirk, by its long peduncles and glabrous leaves."

The *R. trilobatus* here referred to is, I suppose, *R. ternatifolius,* of T. Kirk.

2. **Ranunculus berggreni,** Petrie. Plate XXVI.

I submit for publication a drawing of this plant, also made by Mr. John Buchanan, F.L.S., from the good suite of specimens originally collected by me on the Carrick Range, in Central Otago. The drawings are most faithful, and show very distinctly the peculiar leaves that mark it off from the other native species. These it will be noticed present considerable variety of outline, but in most of my specimens

the base of the leaf is decidedly cordate. The plant seems to me more nearly related to my *R. novæ-zealandiæ* than to *R. lappaceus*, var. *multicaulis*, to which some authorities have been disposed to refer it. Unfortunately, it has not been found in fruit, although I expressly visited the locality to find ripe carpels. As it was a very dry season, every vestige of the plant had disappeared. *R. lappaceus*—in its typical form—grows in the same locality.

3. **Haloragis spicata**, Petrie. Plate XXVII.

This species is known only from the locality at the head of Lake Hawea, where it was discovered by me. The accompanying figure is from the pencil of Mr. John Buchanan, F.L.S., and is in every respect characteristic of the species.

4. **Carex pterocarpa**, Petrie.

I propose this name for the species originally published by me under the name "*Carex thomsoni.*" The latter name is preoccupied, as colonial botanists learned on the publication of the "Index Kewensis."

5. **Carex rubicunda**, Petrie.

This name I propose for my *C. novæ-zealandiæ*, a name that also proves to be preoccupied, having been bestowed on a supposed New Zealand species by O. Böckeler in the German botanical journal "Flora" (1878).

ON THE LATE MR. KIRK'S "REMARKS ON *GUNNERA OVATA*, PETRIE, ETC."

Owing to the recent death of the late Mr. T. Kirk, F.L.S., I shall leave the matters of controversy between him and me as to the relations of *Gunnera flavida*, Col., and my *G. ovata* for the botanists of the future to settle. But there are two points in his recent paper (Trans. N.Z. Inst., vol. xxx.) on which I am called upon to offer a few observations.

Mr. Kirk says I must be under some misapprehension in writing that the authorities at Kew regarded *G. prorepens*, Hook. f., and *G. flavida*, Col., as identical species, and he gives as a reason for this statement that he had not sent to Kew specimens of *G. flavida* until his paper on *Gunnera* appearing in vol. xxvii. of the Transactions had been written, and the comparison referred to by me could not have been made till then. My statement did not refer to specimens forwarded to Kew by Mr. Kirk, but "to Colenso's type of *G. flavida* deposited at Kew." The report from Kew to which I made reference reached me nearly two years before Mr. Kirk's paper was written. The report in question is laid

on the table for inspection by members. The words of Mr. N. E. Brown's report are: "N.B.—*G. flavida*, Col., is true *G. prorepens*, Hook. f." It will be seen that the misapprehension has not been on my part.

Mr. Kirk further says that the drupes of *G. prorepens* are not described by Hooker as being fleshy; but on page 66 of vol. i. of the "Flora Novæ Zelandiæ" Hooker actually uses the term "fleshy" in describing the drupes of this species. In the very brief description in the Handbook this point is not mentioned, and Mr. Kirk was evidently not aware that a much fuller and more accurate description of the plant by the same author was in conflict with his statement on this point.

Art. XXXII.—*An Inquiry into the Seedling Forms of New Zealand Phanerogams and their Development.*

By L. Cockayne.

[*Read before the Philosophical Institute of Canterbury, 7th September, 1898, and 22nd February, 1899.*]

Plates XXVIII.-XXXIV.

Part I.: Introduction.

The investigation of seedling forms of plants is a matter which, until quite recently, has been much neglected, and it was not until the year 1892 that this state of things was in some degree remedied by the publication of Sir John Lubbock's painstaking and admirable work entitled "A Contribution to our Knowledge of Seedlings." In this treatise, which extends to 646 pages, are excellent drawings and descriptions of seedlings belonging to most of the natural orders, together with usually an account of the seed and the embryo. These descriptions in most instances treat of seedlings at certain stages of their growth, but do not trace the life-history of the plant from the germination of the seed to the completed form of the mature plant. The most elaborate portion of the work in question is the classification of the Cotyledons of each natural order, from which is deduced a theory to account for their various shapes. Concerning this theory I do not now propose to speak; any comment will be reserved until such time as my work is completed and its results summarised. Respecting seedling forms of our indigenous plants very little has been published. In the work just mentioned *Linum monogynum*, Forst., *Pittosporum crassifolium*, Banks

and Sol., *Aristotelia racemosa*, Hook. f., and *Veronica salicifolia*, Forst., are the only New Zealand species described. Kirk, in his various writings, has treated at some length, especially in his "Forest Flora," of the young forms of a number of our plants, but mainly those forms which occur together with the mature leaves on old plants, or young specimens of considerable size as found wild; in very few instances, however, has he described an actual seedling from the time of its germination.

From the above considerations it may be seen that a very considerable field is open for investigation by New Zealand botanists. That such investigation is of great interest and importance hardly needs asserting. It may be well, however, to show briefly some of the results which may follow such work. Taking, first of all, systematic botany, much light may be thrown on the relationship of forms, so that we shall be able to determine much more accurately than has hitherto been possible the limits of many of our critical species. If, for instance, two plants have seedling forms exhibiting considerable differences, they would most likely belong to different species; while should the two seedlings be identical it would be a strong argument in favour of the two being identical.

With regard to the first of the above hypotheses, *Panax simplex*, Forst., according to Kirk ("Forest Flora," p. 212), seems a case to the contrary, since it is stated to have two distinct young forms "so widely different from each other that it is difficult to believe they can belong to the same plant." In such a case as this a mistake may easily be made by the most careful observer, and artificial investigation is necessary before the statement can for certainty be accepted. No one, unless well versed in seedling forms of New Zealand plants, however well he might know the mature form, could possibly recognise the seedlings of quite a number of our plants. Here, of the three figures on pl. cvi., only one—No. 3—can claim to represent a young seedling, while Nos. 1 and 2 might very well be later developments of No. 3. Without, however, going into this subject in detail now, different environment, as will be shown later on, has a most marked effect on the same forms in many plants; hence this case, granted that the facts are as stated, may be merely a case of different development under different conditions. And this is the more likely since No. 3 is stated to be the only form found on the Auckland Islands (Hooker), and the prevalent form on Stewart Island (Kirk).

Besides the value of the study of seedlings from the specific point of view, that from the biological standpoint is of far more absorbing interest: the matter of varying environment, mentioned above, may lead to the discovery of most

important facts, while from the differences between the earlier and later developed leaves, and the younger and older forms of the plant, much information as to the phylogeny of a species or of an organ may be afforded. In his recent work, "A Text-book of Botany," Strasburger says (page 46), "A highly organized plant which begins its development with the simplest stages and gradually advances to a higher state of differentiation repeats in its ontogeny its phylogenetic development"; and further on, "From the fossil remains of former geological periods it is safe to conclude that such Conifers as *Thuja*, *Biota*, and the various *Junipers* that now have scale-like compressed leaves have been derived from Conifers with needle-shaped leaves. This conclusion is further confirmed by the fact that on the young plants of the scaly Conifers typical needle-shaped leaves are at first developed. The modified leaf-form does not make its appearance until the young plant has attained a certain age, while in some *Junipers* needle-shaped leaves are retained throughout their whole existence." Reference is also made to the Australian *Acacias*, whose early pinnate leaves in many cases become eventually phyllodes, and he concludes with these words: "That it is permissible on such phylogenetic grounds to conclude that the Australian *Acacias* have lost their leaf-blades in comparatively recent times, and have in their stead developed the much more resistant phyllodes as being better adapted to withstand the Australian climate. The appearance accordingly of the phyllodes at so late a stage in the ontogenetic development of the *Acacias* is in conformity with their recent origin."

In a similar manner, Sir John Lubbock argues ("Flowers, Fruits, and Leaves," page 141) "that the present furze is descended from ancestors with trifoliate leaves"; and further on he explains by an examination of seedling conditions how lobed leaves are of more recent origin than cordate leaves.

Besides the above-quoted instances, many others could be cited from foreign plants,* but in no flora in the world is this phenomenon of such common occurrence as in the flora of New Zealand.† Indeed, it will be seen from subsequent parts of this inquiry that a very large percentage of our plants exhibit most startling phenomena of this kind. And it is not

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* See "Aspects of the Phænogamic Vegetation of Rodriguez," by J. Bayley Balfour, D.Sc., F.L.S., in Journ. Linn. Soc. (Botany), vol. xvi., pp. 7–25.

† On this point I can speak with some authority, since during the past few years I have personally raised from seed several thousands of species of extra-tropical plants, and in few, save certain Australian genera and Conifers, have I noticed any marked changes in leaf-form to take place.

the seedling alone which so behaves; but granted certain conditions—notably such as produce rapid young growth—and the mature plant will revert in part to the seedling form. Some species are so unstable in form that both forms may be found in a state of nature on the same plant at once—as, for instance, when one portion is exposed to sun and wind, while another portion is shaded. Thus at 1,500 m. on the Craigieburn Mountains I have found *Veronica tetrasticha*, Hook. f., with both its scale-like* and its true (seedling) leaves, the latter occurring where a shoot was sheltered by a rock from sun and wind. Many other examples could be adduced from my own observations, but such will be reserved until dealing with each particular species.

Kirk was the first to point out such dimorphism in the whip-cord *Veronicas* (Trans. N.Z. Inst., vol. xi., p. 465), stating that "the dimorphism in the foliage of all the species characterized by appressed leaves has not received the attention it merits. . . . There can be little doubt that the free leaves are equally characteristic of the seedling state of the plant, although I have been unable to find them in a wild condition." That was published in 1878, but quite recently, in the "Transactions of the New Zealand Institute" for 1895, volume xxviii., page 515, Kirk again refers to the subject, writing: "The species of the dimorphic—or, as it might with equal propriety be called, the mimetic—section are invested with special interest, the entire section, with the single exception of the Australian *V. densifolia*, being endemic in this colony. At present, strangely enough, our knowledge of the early leaves of these singular plants has been chiefly obtained from old specimens, on which they are often produced by reversion, especially under cultivation. The subject" [referring to the morphology of these species] "will not be satisfactorily worked out until the seedlings, as well as the more advanced stages, have been studied in a systematic manner." Since such seedling leaves are usually developed on the mature plant—as already pointed out—by conditions which promote vigorous growth, can it be upheld, as a contrary theory to such leaves being ancestral forms, that they are merely special organs designed for the rapid growth of the plant in its early and most insecure period of existence among its often most inhospitable surroundings? This might well be a difficulty but for the fact that the early forms of a seedling plant may be maintained even without specially vigorous growth by giving the plant a certain environment

* It was Mr. R. Brown (Brown ter.) who first demonstrated the true character of the so-called leaves of that section of *Veronica*, in a paper read before the Horticultural Society of Christchurch, but not published in any recognised scientific publication.

which possibly may represent in some degree that of the hypothetical ancestor. Thus a seedling plant of *Veronica armstrongii*, Kirk, pot-bound, and so not subject to vigorous growth, but kept in the mild and somewhat moist climate of my greenhouse, still, although more than two years old and 12 cm. high, keeps in every part its seedling form, and may very well indeed be a veritable reconstructed ancient type (see Plates XXVIII. and XXIX.). The case cited above of *Veronica tetrasticha* may be explained in a similar manner; and finally the leaves may also serve as organs for promoting rapid growth without upsetting the theory of reversion, since the former ancestor, if provided with such leaves, and living under more favourable conditions, would certainly grow much faster than its depauperated descendant. Also, quite a number of plants never quite lose, or, at any rate, keep for a very long time, these seedling forms, which exist side by side under the same conditions with the mature, sometimes even on the same shoot *Parsonsia* (all the species), *Dacrydium* (all the species), *Muhlenbeckia complexa* and *M. adpressa*, *Gaya lyallii*, and *Hoheria angustifolia* afford good examples, while *Pseudopanax* is more remarkable still, since it goes through at least three different forms, and does not assume the last form — most distinct from the preceding, but which is not much unlike the early leaves—until quite late in life.

That such great instability of species should occur in our flora is not to be wondered at when we consider — with Captain Hutton and those later writers who have followed his theories — the diverse origin of our flora, and the comparatively recent great changes which have taken place since all our plant immigrants finally settled down in their island home. This insular habitat, as pointed out by Diels, would, when a change in climate came, cause the survival afterwards of various ancient forms in stations not suitable for their well-being,* whereas in a continent they would under similar circumstances either migrate to a suitable spot or be wiped out by forms better suited to the new conditions. In such an unfavourable locality these survivors would, I may venture to suggest, be modified more or less in outward appearance, but would never become really stable species. A good case in point is *Raoulia bryoides* and *Raoulia mammillaris*, both of which, under cultivation in a greenhouse, develope true leaves, and become in habit much more like their relatives of

* *Carmichaelia crassicaule*, *Raoulia mammillaris*, *R. eximia*, *R. bryoides*, *Haastia pulvinaris*, *H. recurva*, *H. sinclairii*, most inhabitants of shingle-slips, *Veronica* (of the whip-cord and *epacridea* type), *V. buxifolia*, *Ozothamnus*, *Panax lineare*, *Notospartium*, *Epilobium crassum*, *Hymenanthera alpina*, *Carmichaelia monroi*, *C. robusta* (?), *Senecio cassinioides*, &c., are probably examples of such forms.

the river-beds and plains. These latter, indeed, to judge by the seedling leaves of the former, should be the ancestral forms, but it is quite likely that they are reproduced ancestral forms from these now almost defunct species. Such might be called reinstatement of a species, and the *Pseudopanax* quoted before may also be explained on this supposition.

The unsuitability of many well-known and common plants to their surroundings seems worthy of mention here. That very little change in climate would be required to destroy for ever some of our indigenous plants may be seen by their behaviour in cultivation. On the low-lying portions of the Canterbury Plains quite a number of South Island plants are not really hardy. *Fuchsia excorticata*, *Aristotelia racemosa*, *Piper excelsum*, *Schefflera digitata*, and *Myoporum lætum* will at once suggest themselves to any grower of New Zealand plants. Others—*Veronica elliptica*, for instance—are easily damaged by frost. From my paper, "On the Freezing of Alpine Plants" (Transactions, vol. xxx., p. 435), it will be seen that quite a small amount of cold, and that for no very long period, was sufficient to kill fifteen out of twenty-two, and the survivors were nearly all so much damaged that they could hardly hope to survive. A severe winter in a climate so mild as England plays great havoc with most New Zealand plants, many *Veronicas* being hardy only in such localities as Cornwall, Devon, the Isle of Wight, &c. At Castle Hill, in a sheltered ravine, after a severe winter, I have noted *Veronica traversii*, var., very much damaged, and at 1,460 m., on Hill's Peak, on a ridge fully exposed to the wind, at one time covered with vegetation, all was destroyed during the winter of 1896.

It may not be out of place here to give some account of how I have carried on, and propose to carry on, this work. My pursuits as field-naturalist and collector, gathering yearly as many different sorts of seeds as I can procure, puts me in possession each season of seeds of from one hundred to two hundred species of plants, the sources whence all of them were procured being exactly known. These seeds I sow in small pots in very porous sandy loam, keeping those species well apart which belong to the same genera, so that no confusion can arise through seeds being washed from one pot into another. Small seeds, such as *Gaultheria*, *Fuchsia*, *Pratia*, and even larger ones, such as *Veronica*, *Celmisia*, and other Compositæ, I do not cover with earth, for they germinate much better when firmly pressed down upon the surface soil and kept moist. Each pot is labelled with name of plant, date of sowing, and a number which corresponds to the one on the seed-packets as sent to various botanic institutes

with which I correspond; and such number is entered—with an account of the environment of the plant from which the seed was gathered—in a book kept for that purpose. The pots are plunged in sand on the staging of an unheated greenhouse, at no great distance from the glass. The germination of each species is recorded as it occurs. So soon as the cotyledons are developed a magnified drawing is made of them, and a description written; and further descriptions are written and drawings, magnified or not as the case may be, together with nature prints and photographs, are made of the succeeding leaves as they develope. This is kept up until the plant assumes its final form, when it is planted in the garden, or potted and kept in a shade-house for reference, &c. Of course, these proceedings take up a good deal of time, so the work is slow, very few of the New Zealand plants being of quick growth; the seeds, too, are often slow to germinate. So, without waiting for the full results in each particular case, I propose to publish from time to time, in future parts, my results up to date. Nor can there be any systematic arrangement, since plants of most varied natural orders are ready for description at the same time.

Of course, seedlings grown under such artificial conditions may not be identical with those which occur spontaneously in their natural habitats, and I am in the habit of collecting, describing, potting, and noting the changes of the latter, if any, or the differences from the artificial seedling. Dr. Dendy has suggested to me that the first stage of an artificial seedling's existence should not differ in form from one growing naturally, since the embryo in the collected seed was developed under its natural environment, but that a seedling raised from cultivated seed might well show some difference. This suggestion is most interesting, and the differences between two such seedlings should be carefully noted.

The environment of the wild seedling will, when possible, be described, since this differs in much from that of its parent; and although, as I pointed out above, most seedling forms are in all probability ancestral, yet at the same time they may also be adaptations for the benefit of the young plant. Abundance or the contrary of the seedlings of any species, the struggle for existence between the same or different species, and other matters which bear on my subject will be dealt with in due course.

I cannot conclude this paper without referring to my friend, our member, Mr. R. Brown. Some years ago he read a paper on the leaves of the whip-cord *Veronicas* before the Horticultural Society, which was, however, somewhat incorrectly published. His views, which in many respects differ widely from mine, have influenced my thoughts in no small

degree, and I must express how much indebted I am for his early suggestions. Amongst other things, he raised plants of *Veronica armstrongii* from seed, caused *Ozothamnus microphyllus* to revert to what I should call its ancestral form, and grew some very curious forms of *Raoulia*, which are, unhappily, lost. To Captain F. W. Hutton, for assistance regarding literature relating to geological history of our flora, to Professor A. Dendy, for the use of seedling plants, and to Mr. W. Sparkes, for photographing *V. armstrongii* for the accompanying plates, I must also beg to record my thanks.

PART II.: DESCRIPTIONS OF SEEDLINGS, AND NOTES THEREON.

WITH regard to the seedlings described here, it may be well to point out that, where nothing is stated to the contrary, they have been raised by myself in the manner and under the conditions described in Part I. of this memoir, and so it cannot be held that such seedling forms are identical with those to be found wild. Such wild forms I hope to describe or to remark on when opportunity offers; and the comparison between these and artificially raised forms, showing the effect of various environments, should be of interest. As for the measurements given below, since the lengths of most parts of a seedling vary at different periods of its development, such measurements must be looked on as comparative, and serve only to give some idea of the relations in point of size between the different parts of a seedling at some fixed period in its development, and are not in any case a uniform measure for any particular part. Measurements of leaves always include the petiole unless the contrary be stated. With regard to the greater part of the forms described, their development up to the present is not sufficiently advanced to warrant many remarks; the further development of such will be of much greater interest; an account of this I hope to publish in Part III. As for the descriptions, they are drawn up from an examination of all the seedlings raised as far as possible, and are not descriptions of one seedling alone. Many seedlings die after having been examined, while others must of necessity be cut up for examination and so destroyed. Thus it has not been found possible to watch the development in many cases of any particular individual, the further progress of the species having to be noted from the survivors. Besides using herbarium specimens, I have been enabled to compare nearly all the seedling forms with adult plants from my garden. As this garden is of dry sandy soil, considerably exposed to wind

and sun, the majority of plants from the drier regions of New Zealand are growing under much the same conditions, altitude excepted, as the wild plants, and their organs cannot be very different in appearance.

No. 360. **Pittosporum rigidum,** Hook. f. Plate XXX., fig. 4.

Seed collected at Craigieburn, at altitude of 602 m., from a shrub growing on a very dry stony slope, fully exposed to high winds and sun. Sown 12th December, 1897; germinated early in the spring of 1898.

Description of Seedling.

(Development not yet nearly concluded; most mature plant 4·5 cm. high, and with eight leaves.)

Root long, straight, deeply descending; side rootlets few, short.

Hypocotyle 1·8 cm. or more long, straight, bent or twisted towards base, terete, reddish, hairy with brownish short glandular hairs.

Cotyledons three in a whorl, almost sessile, articulate at base; pulvinus dark-purple; lamina 8 mm. × 3 mm., linear-oblong to linear-lanceolate, with sides sometimes unsymmetrical, obtuse or acute, pale yellowish-green; upper surface concave where it merges into the short channelled petiole; midrib evident above and beneath; veins of upper surface often swollen; margin entire, sometimes irregularly waved, ciliated.

Leaves cauline, alternate, cuneate at base, deeply toothed or pinnatifid, usually acute, almost glabrous except on the slightly hairy petiole, or with one or two scattered hairs near the base of leaf; most recently developed leaves crowded towards apex of stem.

1st leaf rarely nearly opposite 2nd leaf, ovate or obovate, 8 mm. × 5 mm., thick, rather coriaceous, green, polished, pinnatifid or very deeply and coarsely toothed with blunt teeth; segments unevenly serrate.

2nd to 5th leaf similar to 1st leaf, but varying very considerably in breadth and length; largest 1·3 cm. × 5·5 mm.; petiole 3 mm.; segments often subulate; later leaves often conspicuously edged with reddish-brown, stained dark at base, and of much duller darker green than earlier; laminæ usually patent and horizontal, but sometimes semi-vertical.

Stem terete, very dark-purple in oldest portions, lighter purple above, covered rather thickly with coarse adpressed white hairs; 1st internode 2 mm. long, remainder varying in length from 2 mm. to 4 mm.

The seedlings examined were remarkably uniform, varying very little from one another. The leaves of adult plants are smaller, dark in colour, much less divided or quite entire, more coriaceous, with obtuse apices and recurved margins, often fascicled on very short branches, and are evidently reduced forms of the greener, larger, pinnatifid, acute, juvenile leaves. This reduction seems to afford a striking example of the effect of environment on leaf-forms—in this case frequent furious gales, no shelter from frost, often insufficient moisture, a very clear atmosphere, fierce sunshine, and very poor stony ground. And it is worthy of remark that the majority of the shrubs growing in company with *P. rigidum* have sometimes reduced leaves almost identical in shape, and at other times leaves of different shape but still much reduced. Such, for example, are *Coprosma* (several species), *Hymenanthera* (several species), *Panax anomalum*, *Veronica* (several species), *Discaria toumatou*, *Clematis marata*, *Rubus cissoides*, and *Aristotelia fruticosa*, this last having in one of its early forms pinnatifid leaves.

A form of *P. rigidum* from Mount Hikurangi, kindly sent to me by Mr. D. Petrie, F.L.S., has much larger leaves, obovate or oblong, and resembles the plant figured in the "Flora Novæ Zelandiæ" (vol. i., pl. x.) much more than the southern form. It is quite possible that this Canterbury form, here treated of, may be specifically distinct from that of Nelson and the North Island, but, until seedling forms of these latter are studied and experimented with, it will be impossible to settle the point. Seedlings of the little-known *P. obcordatum* would also be of great interest, and would help to throw light on these anomalous forms of *Pittosporum*.

No. 504. **Carmichælia hookeri,*** T. Kirk. Plate XXX., figs. 6, 7, 8.

Seed gathered by Mr. T. Kirk, F.L.S., at head of Porirua Harbour. Germinated in about three weeks.

Description of Seedling.

Root stout, with many fibrous strong lateral rootlets.

Hypocotyle very short, thick, green, terete.

Cotyledons increase in size after germination, from 4 mm. to 7 mm. in length, obovate or oblong, from dark to pale green, paler on under-surface, thick, fleshy, short-petioled; petioles finally 1 mm. to 2 mm. long, channelled, connate at base, slightly hairy or glabrous; sides of lamina unsymmetrical; midrib just evident on under-surface, or slightly swollen towards base of leaf.

* "On Carmichælia," &c., by T. Kirk, F.L.S. ("Transactions of the New Zealand Institute," vol. xxix., pp. 506, 508).

Leaves (Plate XXX., fig. 7) distichous on edge of stem or cladode, becoming much depauperated as development proceeds, cauline, petiolate, stipulate, at first green, then variegated with light stains at base, finally brownish-purple.

1st leaf (Plate XXX., fig. 8) rotund, subrotund or obcordate, variable in size; lamina from 1 cm. × 1 cm. to 7 mm. × 6 mm., rounded or slightly cuneate at base, emarginate, ciliate with a few scattered deciduous (?) hairs, pale-green on upper but much paler on under surface, very sparingly pilose with a few adpressed white hairs; margin entire, often purplish; midrib reddish at base; veins evident below; petiole 7 mm. long, channelled above, terete beneath, articulated at junction with midrib, the articulation becoming more evident as development proceeds, slightly hairy, articulated at base, and furnished with two short membranous, triangular, adnate stipules, which are purple and hairy, especially at apex.

2nd leaf similar to 1st leaf, but usually rather smaller.

3rd leaf as 1st or 2nd leaf, or sometimes as 4th leaf.

4th leaf ternate with three obcordate leaflets, similar in hairiness, &c., to the previously described leaves; lateral leaflets 2·5 mm. × 2 mm., often larger, articulated to midrib; terminal leaflet much larger than lateral, 6 mm. × 4·5 mm.; petiole 6 mm. long, similar to those described above.

Stem usually at first grooved and ribbed, sometimes 4-ribbed or merely angled, almost glabrous, soon becoming through flattening of its surface and reduction of leaves a leafy cladode.

Leafy cladode (Plate XXX., fig. 6) dorsiventral in all the seedlings raised except one*; upper surface terete, 4 mm. wide, furrowed with usually six to nine shallow furrows, dark-purple, dotted with minute white scales, canescent with short white bristly adpressed hairs in adjacent patches; ridges paler than furrows, translucent; under-surface flat, much less hairy than upper surface, or almost glabrous, except for dotting of minute scales, never canescent, always much grooved; margins pink, translucent, much notched; notches rounded, with pale-coloured upper margin swollen and extending as a transverse striation or swelling half across the stem on both surfaces; internodes, in plant 13·5 cm. long, 6 mm. long, 3 mm. broad at base, 4 mm. broad at notch, 2 mm. thick.

Further development: The succeeding leaves are more and more depauperated, the lateral leaflets being smaller

* This exceptional seedling differs chiefly in the upper surface not canescent, and in its much thinner texture; its under-surface, however, is more distinctly furrowed than the upper.

and smaller, until one, and then both, are suppressed, only a very small terminal leaflet being produced. Finally leafless cladodes are developed from the lower nodes, sometimes at first furnished with one or two minute leaflets.

Leafless cladodes flat, dorsiventral, distichous, usually curving downwards, notched at nodes, furrowed on both surfaces but more so on under-surface, canescent on upper surface, often stipulate on upper margin of notch.

The leafless species of *Carmichælia* seem to exhibit usually three stages of development—first, a wiry (Plate XXX., fig. 9) or thick-stemmed (Plate XXX., fig. 8) seedling, with simple or compound leaves; second, leafy cladodes arising from the axils of the primary leaves; and third, quite leafless cladodes, often extremely thick and stout. The second form may be artificially produced in an adult leafless plant by cultivation in shady, sheltered, moist situations (see Plate XXXI., fig. 13); such also occurs spontaneously in a state of nature, but I have not had an opportunity as yet of accurately investigating such a change. Certainly shade and its accompanying moisture is here also a factor. *C. flagelliformis*, on the Port Hills, is in full sunshine leafless or almost so, and in shade of trees a quite leafy plant. Compare also the permanently leafy (deciduous in winter) *C. grandiflora*, growing only in positions where it receives the full western rainfall, it being the common *Carmichælia* of Westland, with the leafless *C. robusta** of the Trelissick Basin.

Carmichælia gracilis, Armstg.† Plate XXX., figs. 1, 2. (Syn. *C. kirkii*, Hook. f.)

Seed collected from one plant, growing in rather swampy ground, at foot of sand-dunes near New Brighton, Canterbury. Germinated in about ten days.

Description of Seedling.

Root long, straight, white, fleshy at base, with numerous lateral rootlets.

Hypocotyle stout, very rigid, terete, tapering from the base upwards, smooth, glabrous, pale, tinged at times with purple, 5 mm. long, partly subterranean, at times slightly flexuous.

Cotyledons extremely fleshy, persistent for a considerable time, increasing in size, at first 7 mm. to 8 mm. × 4 mm. to 5 mm., finally even 1·6 cm. × 9 mm., and 1·25 mm. thick, unsymmetrically oblong or obovate-oblong, entire, with purple

* Of course, it must be a matter of doubt what plant was meant by Kirk as *C. robusta* without access to his unpublished work, and to his herbarium, lately acquired by the New Zealand Government.

† "Descriptions of New and Rare New Zealand Plants," by J. B. Armstrong (Trans. N.Z. Inst., vol. xiii., p. 336).

margin, glabrous or with a few scattered hairs on under-surface; upper surface flat; under-surface convex; petioles short, slightly channelled above, connate at base.

Early development: While the first leaves are in the bud, or slowly unfolding, the stem is being rapidly developed, attaining in some specimens a length of 2 mm. By the time the plant has attained a height of 2·45 cm. it possesses three leaves fully or nearly fully developed, from the axil of each of which, and also from the axils of the cotyledons, a shoot is being pushed forth.

Leaves cauline, distichous, large, inserted on margin of stem when latter is flattened. long-petioled, stipulate, spreading, with upper surface of leaflets horizontal.

1st leaf (Plate XXX., fig. 2) 1·3 cm. long; lamina 5 mm. or 6 mm. × 4 mm. to 6 mm., obcordate or rotund-emarginate, entire with red margin, yellowish-green but rather paler on under-surface, glabrous; nerves not visible; midrib raised considerably on under-surface; petiole articulated to midrib at about 5 mm. from base of lamina, semi-terete, channelled above, brownish, articulate at base.

2nd leaf variable in size, in some cases 2 cm. long, ternate, each leaflet articulated to petiole by a prolongation of its midrib; leaflets very similar in all respects to 1st leaf; petiole articulated at base, furnished with a few scattered hairs.

Succeeding leaves (Plate XXX., fig. 1)—largest plant examined 28 cm. long and with fourteen leaves—very similar to 2nd leaf, but lateral leaflets usually smaller than terminal, and rarely very much reduced, variable in colour from bright-green with brown margin to brownish dotted minutely with pink and pink margin and midrib; laminæ almost glabrous, with a very few hairs on the margin or midrib; petioles with scattered white bristly hairs on margin.

Seedling leaves as compared with adult leaves: Seedling leaves are much larger, thinner, and paler green than adult leaves, which, moreover, become smaller and smaller towards tip of branch.

Stem dark-purple, semi-erect or decumbent, at first wiry, terete, almost glabrous or marked with minute white scales in parallel longitudinal rows separated by hardly raised glabrous ridges. As development proceeds from the 3rd internode upwards, or even sooner, the upper surface of the stem becomes quite hoary with adpressed white bristles, and at the same time is slightly flattened and broadened, but not flat; under-surface marked with ridges and lines of scales more evident than in early internodes, slightly hairy; internodes very constant in size, lengthening with development. Of plant 28 cm. long they are 2 cm. long and 2 mm. broad; of plant 10 cm. long they are 1·6 cm. long.

Stipules triangular, lacerate or bristly at apex, adnate, embracing base of petiole.

In its natural habitat *C. gracilis* is a plant with long straggly usually quite leafless stems, spreading and becoming entangled in the neighbouring vegetation and itself, after the manner of some of the New Zealand forms of *Rubus* and *Muhlenbeckia*, which in habit it much resembles, such being very different indeed from that of typical species of *Carmichælia*. Where the stems are sheltered adult leaves are developed as described above. Cultivated in a moist greenhouse a plant rapidly developed shoots not unlike the juvenile form, but when this same plant was removed to a very dry situation in my garden the new stems that were produced were almost leafless. The seedling form puts one in mind of *C. exsul*, of Lord Howe Island (*vide* fig. 4A, page 266, in Diels's work*) and it looks far more adapted for a moist forest region than for a lowland swamp liable to drought in summer.

Carmichælia crassicaule, Hook. f. Plate XXXI., figs. 12 and 13 (*Corallospartium*, Armstg.).

Seed collected at Mount Torlesse, from plants growing on stony hillside below the winter snow-line, in dry clayey soil, and exposed to wind and sun. Germinated in about four weeks. The seed was quite soft when gathered.

Description of Seedlings.

(The most developed of the seedlings were grown by Professor A. Dendy, D.Sc., and kindly given me for this work.)

Root long, deeply descending; lateral rootlets few, short.

Cotyledons 6 mm. × 4 mm., unsymmetrically oblong, sometimes falcate, obtuse, fleshy, entire, with faint-red margin, glabrous, darker green on upper than on under surface; petioles connate at their base, semi-terete, channelled above, pointing upwards and outwards; lamina with surface quite horizontal.

Stem notched at nodes; 1st internode variable in length, 3·5 mm. to 5·5 mm., almost terete at base, slightly angled, dotted with minute scales in young plant 1·9 cm. high, and hairy with long matted white hairs in plant 4·3 cm. high; 2nd internode in the younger plant almost glabrous and more deeply grooved than 1st internode, in the older plant similar to 1st internode; 3rd internode hairy, as described for older plant. In the older plant the stem is much thicker than in the younger, purplish-brown, with very deep furrows and prominent longitudinal ridges marked with one or two longi-

* "Vegetations-Biologie von Neu-Seeland," L. Diels, Leipzig, 1896.

tudinal purple lines; margin furnished with a narrow pink transparent wing on each side.

Leaves cauline, entire, narrow-ovate, broad-ovate or almost rotund, at first opposite, afterwards distichous through flattening of stem, shortly petioled, dull dark rather glaucous green on upper surface, much paler glaucous on under-surface, stipulate with two membranous broadly triangular hairy stipules; margin edged with reddish-brown; midrib sunken on upper keeled on under surface; veins sometimes swollen on upper surface and much reticulating; apex retuse or emarginate; petiole jointed at junction of lamina and midrib.

1st leaf 6 mm. × 4 mm., in one plant much larger and rotund-emarginate.

2nd leaf sometimes rather smaller than 1st leaf.

3rd leaf a little larger than 1st leaf.

4th leaf 1 cm. × 8 mm.

Later developed leaves more hairy than those preceding.

Further development: In the largest seedling examined, 5 cm. high, flattened hoary cladodes are being developed, longest 2 cm. long, with four leaves similar to but smaller than those on the main stem; laminæ semi-horizontal.

Leafy cladodes on adult plant (Plate XXXI., fig. 13): Under the influence of shade, moisture, and shelter, also perhaps of heat, leafy cladodes are developed with extraordinary rapidity, growing as much as 8 cm. in a space of four weeks, with internodes 2·5 cm. long, 5 mm. broad, 3 mm. thick, shallowly grooved; grooves filled with white, slender, weak, straggly hairs; ridges glabrous; nodes much notched, swollen, and rounded, from each of which arises a small, narrow, linear-oblong, emarginate, fleshy leaf, cuneate at the base, with sides inflexed and surface reflexed from centre. Similar cladodes are developed sparingly on plants in their natural habitats during early spring.

Leafless cladode on adult plant deeply grooved; grooves separated by longitudinal ridges 1·5 mm. wide, yellow towards margin and marked down centre by a green line; grooves filled with dense white matted tomentum; internodes 1·5 cm. long × 9 mm. broad × 6 mm. thick; nodes marked by deep notches furnished with two depauperated stipules, or 0. Such a cladode was developed in my garden on a plant in the open air, partly exposed to north-west and south-west wind and full sunshine, while its sister plants—one in a shade-house and the other under a bell-glass, and kept very moist—developed leafy cladodes as described above.

The development of *C. crassicaule* is of great interest. Apart from its being one of the most singular plants of which our rather anomalous flora can boast, it is, although widely

spread, extremely local and limited in its distribution, and is confined to most inhospitable situations on the mountains at an altitude of from 690 m. to 1,200 m. Wild seedlings are unknown to science, and, although such doubtless exist, their quantity must be small, and young plants also are very scarce. The plant, however, adapts itself very readily to cultivation, and, as stated above, quickly responds to change of environment by developing leafy cladodes, which must assist its growth very considerably. It seems possible from a consideration of these facts that the wild plant was once much more common, and that it is now dying out. Also, that if not an ancient type in the sense that it has existed from a remote geological time, still it may very well be the survivor of a race whose prime dates back for a very considerable period, and whose days are now numbered. (For microscopic drawing of stem, see Diels, page 266, fig. 4c.) The hairs simply covering the stem, often somewhat sparsely in the young plant, and afterwards being confined to the furrows in which lie the stomata, is very interesting.

Carmichælia odorata, Col. Plate XXXII., fig. 24.

Seed from garden of Dr. E. G. Levinge, Sunnyside; the plant said to have been originally brought from the Hawke's Bay District. Germinated in about four weeks. Tallest plant examined, 2·5 cm. long, and with three leaves.

Description of Seedling.

Root white, straight, deeply descending, with few lateral rootlets.

Hypocotyle mostly subterranean, 7 mm. long; subterranean portion fleshy and white, thicker than the green short aerial portion.

Cotyledons oblong, obtuse, fleshy, dotted with numerous white scales, light-green, tapering into the very short broad connate petioles.

Stem terete, grooved and ridged; ridges narrow, glabrous, translucent; grooves even, dotted with scales similar to those on cotyledons; internodes flexuose, in tallest seedling 1st is 5 mm. and 2nd is 4 mm. long.

Leaves distichous, bright light-green, almost glabrous, except for scales as on cotyledons, stipulate with triangular sometimes lacerate hairy stipules; petioles long, semi-terete, channelled above, articulated at base.

1st leaf: Lamina 7·5 mm. × 6 mm., entire, oval or subrotund, emarginate, green above, much paler beneath; midrib slightly sunken on upper raised on under surface; petiole 6 mm. long.

2nd leaf ternate (10 mm. long) or imparipinnate (1·3 cm.

long); leaflets entire, obcordate, glabrous, except for a few scales, jointed to petiole, cuneate at base; apex emarginate or retuse, with sometimes a slight mucro in the centre of the sinus.

3rd leaf similar to those described, but not yet fully developed at time of writing.

As the development of the seedlings under examination is not yet far enough advanced, I have reserved comparison with mature form for future occasion.

No. 514 **Ozothamnus depressus**, Hook, f. Plate XXXIV., figs. 50 and 51.

Seed collected from plant growing on stony bed of River Kowai. Germinated in about four weeks. The seed germinates very freely, but it is difficult to keep the young plants alive for any lengthy period.

Description of Seedling.

Hypocotyle at first succulent, very early on becomes woody, and is already 4 mm. long, as the tip of the first leaf can just be seen arising from between the cotyledons.

Cotyledons (Plate XXXIV., fig. 51) 2 mm. long, broadly oblong, obovate, almost obcordate at times, sometimes unequal in size, emarginate, obtuse, retuse or truncate, indistinctly pubescent with very short white hairs, sessile, amplexicaul, at first erect protecting the 1st leaf, then becoming more patent.

1st pair of leaves (Plate XXXIV., fig. 50) 2·5 mm. long, linear-oblong to linear-spathulate, amplexicaul, very succulent, densely woolly with long matted hairs which are erect and adpressed to stem below, patent above, with apex curving downwards.

2nd pair of leaves 3 mm. long, similar in other respects to the 1st pair.

Stem terete, very soft and succulent, very pale-green, woolly but not so much as the leaves; 1st internode 1·5 mm. long; 2nd internode 2 mm.; or the internodes may be almost suppressed or very indistinctly seen, owing to the leaves being so closely adpressed to the stem. Before the opposite leaves open out their hairs are all matted together into one mass.

In the mature plant the leaves are most closely adpressed with ventral surface to stem, and covered, as in seedling, with dense matted cotton; the dorsal surface, also equally tomentose in the seedling, is in the adult covered with a silky pellicle, and the internodes are almost suppressed. Plants cultivated in a shade-house have put forth shoots with adpressed leaves, but green on the dorsal surface, much less

hairy than the seedling leaves, but in other respects almost identical; so far, however, I have not succeeded in getting a shoot to revert to the actual seedling condition. *O. depressus* is one of the most extraordinary-looking plants in New Zealand; even a most healthy plant, with its stunted, rigid, naked branches and small scale-like hoary adpressed leaves, seems to the eye hardly to possess life. It grows on dry river-beds in subalpine or even in quite low regions, ascending sometimes, but rarely to the alpine zone, where it occupies the most arid and barren regions, forming in the former situation considerable colonies. I have never observed wild seedlings, but that must be more from my not having known the seedling form than from their scarcity. The plate in the "Flora Novæ Zelandiæ" gives very little idea of the habit or appearance, and represents an altogether more natural looking plant. I have never seen plants of anything like the size—5 ft.—of that mentioned in the "Handbook of the New Zealand Flora" (page 146).

No. 435. **Rubus australis**, Forst., var. **glaber**, Hook. f. Plate XXXII., fig. 21, and Plate XXXIV., figs. 67 and 68.

Seed collected from plant growing at the base of Mount Earnslaw, Lake Wakatipu, at altitude of 340 m.

Description of Seedling.

Root fibrous, descending, sparingly branched.

Hypocotyle 4 mm. or 5 mm. long, pale, terete, fleshy, glabrous or very slightly hairy.

Cotyledons narrow-oblong, 4 mm. × 2 mm., acute with slightly swollen tip, ciliated with transparent white glandular hairs; petiole very short, erect, with lamina at right angles.

Stem terete, reddish; internodes at first very short, lengthening as development proceeds, furnished with very slender white or brownish hairs and numerous glands with red swollen tips (Plate XXXIV., figs. 67 and 68).

Leaves alternate, extremely membranous.

1st leaf ovate-cuneate, rotund or broadly oblong in outline, 8 mm. × 4·5 mm.; margins wavy or entire on lower and deeply toothed on upper half, with glandular swollen red teeth; lamina sparsely hairy with glandular hairs, as on stem; venation distinct, reticulated; petiole subterete, channelled above, three-fifths length of lamina.

2nd leaf very similar to first, but with venation more marked.

3rd leaf ovate, deeply toothed except at rounded base, almost glabrous except on under-surface; midrib and nerves swollen below, purplish, especially midrib; petiole channelled, sheathing at base.

Succeeding leaves very similar, but become more triangular, often ovate-lanceolate, more rugose above, while below the veins form a complete pink network, sometimes with reddish-brown round apex, and sometimes cordate or subcordate at base; each young leaf as it developes at first perfectly bristles with hairs.

The extreme thinness of the seedling leaves as compared with those of the adult plant is of interest. The seedlings have been grown in a moist greenhouse, and abundantly supplied with water. A prostrate form of *Rubus* recently brought by Mr. S. D. Barker from Glen Bonnie, Westland, and growing in the forest in complete shade, has mature leaves remarkably like those described above, while in the very wet forests of that district the common *Rubus* (possibly *R. cordata*,* Armstg.) has leaves of a very thin texture. The adult form of the seedling plant described has leaves coriaceous and stiff, with much smaller toothing (in comparison to size of leaf), very smooth and polished on the upper surface, a leaf-structure well suited to resist the drying influence of almost constant winds.

Sophora microphylla, Ait. Plate XXXII., fig. 25.

Seed gathered from plant growing on bank of Broken River, near its junction with the Waimakariri. Germinated very irregularly, some in four weeks, some in twelve weeks, and some took much longer still.

Description of Seedling.

Cotyledons hypogeal, thick, fleshy, obovate, obtuse, falcate, plano-convex, with the flat sides together and not separating, 9 mm. × 6 mm., and the two together 7 mm. thick.

Stem at first tapering from the base, subterranean part paler white than aerial, grows very rapidly at first, 2·3 cm. long before any leaves are fully developed, afterwards yellowish-brown, scaly and hairy with adpressed hairs, at first straight, then flexuose, branching at each node at first; young twigs extremely bristly, with adpressed greyish-white bristles; internodes, in plant 9 cm. high, at first 1·1 cm., later ones longer, 2·1 cm.

Leaves: First few simple; afterwards ternate and imparipinnate, exstipulate, petiolate, bright yellowish-green, alternate; leaflets obcordate, varying in width and size, articulated to petiole, slightly hairy on under-surface, penninerved; nerves and midrib raised beneath; under-surface pale bluish-green; margins faintly incurved, thickened; petioles channelled, hairy, semi-terete.

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* Trans. N.Z. Inst., vol. xii., p. 338. Merely the name is given, with no description except "Leaves cordate."

1st leaf broadly linear, curving downwards, sides incurved, 5 mm. long.

2nd leaf usually simple, but larger or sometimes ternate, with one of the lateral leaflets much reduced.

5th leaf, two lateral and one terminal leaflet, which is rather larger than the lateral; leaf 1·6 cm. long; lateral leaflets 6·5 mm. × 5 mm.

This species was included by Hooker with *S. tetraptera*, Ait., as var. *β microphylla*, although he distinctly states that the two forms are very distinct, and remain so under cultivation.* Kirk also considered that there was only one species of *Sophora* in New Zealand,† and divided it into three varieties and one sub-variety. The seedling form, however, of the plant under consideration differs much from that of *S. tetraptera*, var. *grandiflora*, its stem being more slender and flexuous, branching at an earlier age, in colour more yellow, and with leaves and leaflets much smaller—*e.g.*, the 5th leaf in *S. microphylla* is 1·6 cm. and lateral leaflet 6·5 mm., while in *S. grandiflora* (Plate XXXIV., fig. 71) it is 2·5 cm. and the lateral leaflets 1·2 cm. A form from the Chatham Islands, given to me by Mr. S. D. Barker, seems also distinct in its seedling form (I have only one plant). This early on developed more leaflets in each leaf than in either of the above, while in size these are intermediate between the two (Plate XXXIV., fig. 70). Seeing these well-marked differences in the juvenile forms of *Sophora* in New Zealand, I hold that there are certainly two, and perhaps four (*S. prostrata*), quite distinct species, which will possibly vary very considerably; nor is it unlikely that they may hybridize, and so produce some of the so-called "intermediate" forms.

No. 341. **Veronica cataractæ**, Forst.

Seed *from* cultivated plant in *garden of* Mr. A. Bathgate, Dunedin; the plant originally from one of the West Coast sounds.

Description of Seedling.

Hypocotyle short, pale, terete, glabrous, fleshy, 2–3 mm. long.

Cotyledons rotund-oblong, obtuse or subacute, fleshy, rounded at base of lamina, glabrous, pale; petioles very short, connate at base.

1st leaf 2·7 mm. × 1·5 mm., oval, acute, entire, glabrous; petiole short.

2nd leaf similar.

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* "Handbook of the New Zealand Flora," p. 53.

† "Forest Flora," p. 85.

3rd leaf: Shape similar, but with petiole nearly as long as lamina.

Up till about the 6th leaf the newly produced leaves are similar to the above, except that leaves with one or two teeth on each side make their appearance.

6th leaf 1·4 cm. × 8 mm., obovate, lower third cuneate and entire, upper two-thirds serrate, with four or more serrations, acute, pale shining green above, much paler beneath; midrib sunken; petiole one-third as long as the leaf, channelled, with two minute, adnate, hairy, chaffy stipules at base.

Stem terete, pale, with internodes variable in length, bifariously hairy, the two rows on each internode alternate with those on the succeeding; hairs very close, and curving upwards at the tip; adventitious roots are early formed, coming from the lower nodes.

Variations not many; the petioles may be shorter than those described for the 5th leaf, and the laminæ oval, and thicker in texture.

The seed germinated very freely, and the seedlings became much crowded. On this in large measure depended the variations, length of internodes, and texture of leaves. The plants grow very slowly indeed, much more slowly than the shrubby *Veronicas*, and this is surprising when we consider the moist misty atmosphere of their native habitat.

Veronica salicifolia, Forst. Plate XXX., figs. 3, 3*a*, 3*b*.

Seed gathered from plant on bank of Broken River by A. H. Cockayne, at altitude of 600 m. Germinated in about four weeks.

Description of Seedling.

Root at first straight, white, fleshy, soon becomes much branching from near junction with hypocotyle; branches wide-spreading, slender.

Hypocotyle white, fleshy, 3 mm. long or less, lengthening very little as plant grows, terete, minutely hairy.

Leaves vary somewhat, especially in early stages, bright-green, polished above, slightly toothed or quite entire; later leaves conspicuously and evenly serrated with serrations 1 mm. long; petioles of early leaves one-third length of lamina, or even more, in later leaves hardly one-seventh as long until finally the adult leaves are almost sessile; early produced leaves ovate, oval, or ovate-lanceolate, the succeeding leaves passing through a gradual transition of forms, and so becoming a little narrower until the final adult lanceolate leaves are alone produced.

1st to 6th pairs of leaves (Plate XXX., figs. 3*a*, 3*b*) are

of the early ovate type, minutely hairy, with one or two blunt teeth or sometimes conspicuously lobed at apex, tapering at base into the short, channelled, connate petioles.

7th pair of leaves and onwards are of the lanceolate type, varying a good deal in width in different seedlings.

Stem at first green and succulent, terete, pilose with hooked hairs with hooks pointing upwards; nodes swollen and purple; internodes, in plant 6 cm. high, very constant in length, about 6 mm. long; branches from base not very numerous, and in young plants producing leaves of the early ovate toothed type.

The above description differs materially from that of Lubbock,* but it is more than possible that the seedlings he described were raised from some form quite distinct from the above. *V. salicifolia*, Forst., is one of those species which Hooker held to include a great number of very different forms connected by supposed intermediates. Baron von Müeller went even further, and reduced all the New Zealand *Veronicas* to one species.† Kirk, in his recent writings, has separated some new species from the *Veronicas* of this section‡—*e.g.*, *V. rotundata*, *V. latisepala*, and *V. squalida*—and probably intended restoring some of those discarded by Hooker, for in the same article he refers to *V. myrtifolia*, Banks and Sol., and I think when the seedling forms of *V. salicifolia*, its branches and allies, are worked out several new species will have to be made. The adult form of leaf in the plant under consideration—a widely spread form in the Canterbury Alps—has the leaf much drawn out and narrowed towards the apex, being quite acuminate. The much greater toothing in the juvenile than in the adult form is of interest. It is suggestive that seedlings grown in very damp localities, such as in the subalpine scrub at the head of Otira Gorge, are toothed to an extraordinary degree, and self-sown seedlings of a closely related form growing in my garden amongst ferns are also much toothed. The channelled connate petioles guide water falling on the leaves to the leaf-bases, where it lodges for a considerable time.

No. 388. **Veronica traversii,** Hook. f. Plate XXXII., figs. 27 and 28, and Plate XXXIV., figs. 62 and 66.

(Probably the typical form.)

Seed collected from a plant at Ribbonwood Creek, Craigieburn Mountains, at elevation of 700 m. Germinated rapidly.

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* "On Seedlings," p. 326.

† "The Vegetation of the Chatham Islands," pp. 45–47.

‡ Trans. N.Z. Inst., vol. xxviii., pp. 528–530: "On *Veronica*," by T. Kirk.

Description of Seedling.

Root fibrous, branching very much from base, spreading.

Hypocotyle usually upright, sometimes slightly bent, succulent, pilose, especially towards axil of cotyledons, 9 mm. long.

Cotyledons broadly rotund-ovate, rarely oval, glabrous or with a few short hairs, obtuse or very rarely emarginate; petioles connate at base and thickened, forming a purple ring round the stem, subterete, slightly channelled above.

1st pair of leaves ovate to broadly ovate. Lamina 5·5 mm. × 4 mm., green on upper reddish-brown to green on under surface, flat, hairy; margin ciliated, with hooked hairs pointing to apex of leaf; petiole half length of lamina, sub-terete, channelled above, connate at base, forming raised ring round stem, as in cotyledons.

2nd pair of leaves similar to 1st pair, sometimes with longer petioles.

3rd and 4th pairs from ovate to ovate-oblong, entire or with one or two teeth on each side towards the apex, gradually narrowed on one side at the base into the slightly channelled petiole, which is about two-thirds length of lamina; pale-green or subglaucous above, often deep-purple beneath, except along margin of leaf, which remains green. Hairs as in 1st leaf.

15th pair of leaves: At about this point the leaves begin to vary considerably from those below, and from similar leaves in other seedlings, in one case being lanceolate, 2·1 cm. × 6 mm.; in another obovate, 1·3 cm. × 6 mm.; and in a third case narrow-ovate, 1 cm. × 4 mm.; all almost glabrous, or at any rate much less hairy than the earlier leaves.

Stem terete, pilose with hairs similar to those on the leaf; internodes (in plant 8 cm. high) 4 mm. long.

The seed from which the above-described seedlings were raised was all gathered from one plant. Although, as might be expected, a certain sameness runs through all the seedlings, most marked differences occur among individuals at all stages, in extent of toothing among earliest leaves and in shape among later leaves—in other words, the individual does not nearly produce itself true from seed. But, regarding the species, I have examined seedlings raised from three other individuals which were distinct from No. 388 and from one another. In each of these a certain type may be seen occurring most frequently, and giving a character to each pot of seedlings; but here also there are many individual differences, and it may be expected that when the adult form is reached there will be several plants so distinct as to look like different species. Among a number of wild seedlings that I possess

even greater differences occur—differences of shape, colour, size, and toothing. This great variation from seed throws a little light on the fact that such a great number of distinct wild forms of this species are to be met with, a species whose individuals do not reproduce themselves with any exactitude, while the species consequently reproduces itself still less exactly. The consequence is that, while certain forms maintain themselves intact, new variations must be of constant occurrence. I hope to return to this subject on some future occasion. When I have examined more material, and experimented with it under varying conditions, then it may be possible to fix limits of variation, and to adduce some reason for the occurrence of certain forms. Cuttings from adult plants put forth shoots with leaves of the seedling type. The hairs on the young leaves tend to retain moisture on the surface of the leaves for some time.

No. 336. **Veronica elliptica,** Forst.

(Var. with very large leaves.)

Seed gathered at Bluff, from plant exposed to sea-spray. Only two seedlings. Germination was very irregular.

Description of Seedling.

Hypocotyle very short, hardly to be distinguished from the root.

Cotyledons quite succulent, convex on under-surface, oblong, obtuse, with short thick connate succulent petioles.

1st pair of leaves oblong, obtuse, entire, minutely hairy; lamina rather large and tapering into the petioles; petioles connate and swollen at the base.

2nd pair of leaves oblong or obovate-oblong, obtuse, with one or two faint teeth on each side; petiole short and more narrow than in 1st leaf, minutely hairy.

3rd pair of leaves obovate, shining, 1-toothed on each side; teeth opposite, half-way towards rounded apex, the toothing making a rounded lobe towards upper end of leaf; lamina patent, channelled down middle on upper surface; midrib evident on under-surface.

4th pair of leaves (in process of development) ciliated towards tips, and with two teeth on each side.

Stem pink, terete, bifariously hairy; internodes 3 mm. long.

No. 402. **Veronica tetrasticha,** Hook. f. Plate XXXIV., figs. 55, 56, 57, 58.

Seed collected from plants growing on the Craigieburn Mountains, on shingle slips, at altitude of from 1,200 m. to 1,500 m. Germination was slow.

Description of Seedling.

Root white, descending, at first with few rootlets.

Hypocotyle 3 mm. long, succulent, terete, white tinged with pink, mostly above ground.

Cotyledons 2 mm. long, very succulent, pale-green or purple-stained; laminæ oblong; petioles fleshy, connate at base.

Leaves spathulate, connate at base of petioles and sheathing, or with 1st leaves perhaps sessile, pale-green above, purplish beneath, covered above and beneath at regular intervals with erect stout hooked white hairs, with hooks turned upwards towards apex of leaf, obtuse, entire, adpressed to stem at base, then patent or semi-patent, finally apical portion curving downwards.

3rd pair of leaves 5 mm. × 2 mm.

Development of leaves (from examination of the growing-point): In an early stage the leaves are quite linear and sessile, very succulent, not marked with purple, closely imbricated round the growing-point, flattened above, rounded beneath, with dorsal surface outwards; then the base lengthens out, forming the tapering base or petiole of the spathulate leaf. In other cases the young leaves have the fully developed form from a very early stage.

Stem very soft and succulent, as is the whole seedling plant, with short internodes 1 mm. to 1·5 mm., but longer in the very early state, and continuing to lengthen after full development of leaf, branching early from the lower nodes; branches semi-erect, leafy; leaves as on main stem.

Variations: Often the lower part of the petiole is hardly adpressed to the stem, and the whole leaf is almost patent. The laminæ vary slightly in breadth. One seedling is stained conspicuously with pink in nearly all its parts.

Between the juvenile and mature plants, so far as observed, there is no resemblance. The adult has much-reduced leaves, closely imbricating and adpressed to the stem, and in shape linear-triangular, with very broad sheathing connate base, fleshy, plano-convex or slightly concave on the dorsal surface, ciliated, especially towards base, with rounded obtuse apex, and dotted with minute hairs on the ventral surface. Brought into cultivation, it quickly responds to the stimulus of moisture and shade, puts forth new growth, especially at the bases of the branches, which soon become furnished with numerous shoots very like young seedling plants, but with leaves not nearly so broad. Towards the apices of the branches the young growth shows many transitional forms, from the mature form, only slightly less imbricating, to linear leaves, patent and spreading, except towards

their bases (Plate XXXIV., figs. 56, 58, 57). The four apical leaves of each shoot in the seedling, as in most seedling New Zealand *Veronicas*, through their margins approaching and often touching, form a cup, which holds water and retains it for a considerable time. The young leaves also are readily wetted, the moisture being retained by the hairs, which may perhaps be organs of absorption. In general appearance this seedling form much resembles that of *Saxifraga oppositifolia*, L., also a Xerophyte, and growing in the high mountains of Europe.

No. 520. **Veronica raoulii,** Hook. f.

Seed gathered from plant growing on rocky face at gorge of Broken River by A. H. Cockayne. Seed germinated rapidly.

Description of Seedling.

Hypocotyle wiry, usually procumbent, variable in length, 1 cm. more or less.

Cotyledons rather fleshy, glabrous or furnished on petiole with very minute transparent hairs, 6 mm. long; lamina entire, ovate, obtuse, green above, purple beneath or purple on both sides; petioles subterete, flat or slightly channelled above, connate at base.

Stem ascending, often bent towards extremity, terete, sparingly hairy with usually very short hairs; internodes variable in length (owing probably to the plants examined being much crowded).

1st pair of leaves ovate, crenate, at first 8 mm. long, faintly hairy with very minute hairs, especially on the petiole, dull-green on upper surface, purple on under-surface, with evident midrib; petioles as long as or a little longer than lamina, subterete, faintly channelled above, connate at base.

2nd pair of leaves very similar to 1st pair, channel of petiole continuing half-way up lamina; margin of leaf slightly recurved, especially towards obtuse apex.

V. raoulii grows on dry rocky faces, often exposed to full sunshine, at an elevation of from 600 m. to 900 m. I have never found any wild seedlings, and, although widely spread, it never occurs very abundantly. Formerly it was found on stony river-beds on the Canterbury Plains, according to Mr. T. W. Adams, and there also it would be exposed to very great drought. In cultivation in my shade-house plants from Mount Isabel, Hanmer Plains district, have reverted in their young growth to a semi-juvenile form with thin spathulate leaves, lobed at apex, and with two teeth on each side, with petiole equalling lamina—a very different form from the adult, with its thick, coriaceous, yellowish-green, linear-spathulate, short-petioled, serrate leaf.

No. 354. **Veronica obovata**, Kirk. Plate XXXII., fig. 23.

Seed collected from plant growing on bank of Craigieburn Creek, at 800 m. altitude. Germinated quickly.

Description of Seedling.

(Plant from which the measurements were taken was 3·5 cm. high.)

Root stout and woody at base, very deeply descending, brownish; lateral rootlets few, short.

Hypocotyle 6 mm. long, terete, pale-green, glabrous.

Cotyledons obovate; lamina 5 mm. × 3 mm., pale-green, entire, obscurely retuse, marked with a few most minute hairs, tapering slightly at base into petiole; petiole 2·5 mm. long, flat, connate at base. Leaves spreading, often patent, petiolate, subglaucous, much more crowded towards ends of branches.

1st pair of leaves 6·25 mm. × 4 mm., narrow-obovate, subacute, entire, furnished with numerous most minute hairs, tapering into the petiole; petiole 5 mm. long; midrib swollen below towards base of leaves; margin slightly recurved.

2nd pair of leaves similar.

3rd to 6th pairs very similar to above, but sometimes marked with one or two rather deep serrations.

Later-developed leaves sometimes stained with red at apex and on teeth (when present), and with shorter petioles and broader laminæ.

10th pair of leaves: Lamina from one seedling 1 cm. × 6 mm. and from another 1·1 cm. × 6 mm.; petioles 2 mm.

Stem soon branching from lower internodes, terete, pale, sometimes pinkish or bright-pink, extremely pubescent with short hooked hairs; internodes 3·5 mm. long; nodes slightly swollen, pink or purplish.

The seedlings examined did not vary to any great extent. Their growth appears to be slow.

Nos. 310, 634. **Veronica epacridea**, Hook. f. Plate XXXIV., figs. 59, 60, 65.

Seed from two sources—No. 310 gathered from plants on the western side of one of the rocky peaks of the Craigieburn Mountains, at altitude of 1,860 m.; and No. 634 from plant growing on shingle-slip on Mount Torlesse Range, at altitude of 1,000 m. Seed germinated in about four months.

Description of Seedling.

Root slender, deeply descending, with numerous side rootlets.

Hypocotyle one-half subterranean, 2·5 mm. long, terete, purplish on aerial part.

Cotyledons 3 mm. × 2 mm., fleshy, triangular-oblong, obtuse, glabrous, entire, with broad petioles; petioles connate at base, equalling lamina.

1st pair of leaves broadly triangular-ovate, obtuse, patent, curving downwards towards apex, sparingly hairy with minute hairs on upper surface, truncate or subtruncate at base; under-surface broadly keeled; petioles deeply and broadly channelled, connate at base, equalling lamina, which is 4 mm. × 3 mm.

2nd pair of leaves similar to 1st pair, but rather larger.

Later leaves (up to 8th pair) still of same type, but sides bending inwards, making upper surface concave; petioles from semi-patent to almost adpressed to stem.

Leaves on branches: These are considerably smaller and much more arched than leaves on main stem, the petiole semi-erect and lamina bent, arching downward almost at right angles, with apex recurved.

Stem very early in development branches from base, at first quite succulent and fleshy, more or less purple, sparingly minutely pubescent, terete; internodes 2 mm. long, but much shorter towards apex of stem.

Variations: The two batches of seedlings vary considerably from one another: first, in colour—634 pale-green, only later leaves faintly stained on margin with purple; 310 dark-green, edges of later leaves very deeply stained with purple; second, in size of internodes, 310 having much larger internodes; and, third, in size of leaves, the younger (634) having larger leaves than the older (310). The individuals of each batch do not seem to vary to any extent, but not sufficient seeds have germinated to warrant any conclusion.

The whole plant is very succulent and soft. Such structure is an admirable provision against drought, growing as it does on solid rock or shingle-slips, for it cannot put down a long root in search of water as the adult plant can; nor is there so much danger of its drying up with excessive transpiration, since, being of very low stature, the large stones of the shingle-slips or the fissures in the rock, where alone the seed can germinate, will protect it from the drying winds. The same remark would apply to *V. tetrasticha*, a companion plant. It is curious that this soft succulent form of leaf is the permanent form of *V. haastii*, a closely allied plant, restricted to regions subject to the western rainfall.* *V. epacridea* has adult leaves (Plate XXXIV., fig. 65), extremely

* In the Handbook it is said to grow on Mount Torlesse; it must, however, be very rare; whereas in the position indicated above *V. haastii* grows with the greatest luxuriance, trailing in long patches over the stony ground. I think it most likely that the Torlesse plant was a very open-leaved or a young form of *V. epacridea*.

coriaceous, more or less imbricating, subsessile, and in my cultivated plants ciliate towards the base. Hooker says glabrous.

Veronica pinguifolia, Hook. f. Plate XXXIV., figs. 61, 63, 64.

(Var. with prostrate stems, rooting freely from the nodes.) Seed from cultivated plant in Tarata Garden.

Description of Seedling.

Root remains enclosed in seed for considerable period; in one case the stem was furnished with two pairs of leaves before it emerged, at first quite coiled up, finally descending, with very many filiform lateral rootlets.

Hypocotyle 5 mm. long. terete, green or pinkish.

Cotyledons 5 mm. long, ovate-oblong, obtuse, green above, sometimes purplish on under-surface; midrib hardly evident; petioles connate at base.

Leaves pale-green, pinkish, or margin more or less deeply stained with pink; topmost crowded; earlier leaves with petioles semi-erect, and laminæ spreading and curving downwards often, usually narrow- or broadly-ovate, obtuse, with petioles from one-third to one-half length of leaves; more mature leaves broader, almost rotund at times; midrib slightly raised on under-surface; both surfaces dotted with many minute white scales; still later leaves obovate, almost sessile, quite glaucous above, with a red margin.

1st pair of leaves narrow-oblong or obovate, obtuse, green on upper sometimes purplish on under surface; midrib partly evident; petioles connate at base.

Adult leaf (Plate XXXIV., fig. 63) coriaceous, 1·3 cm. × 7·5 mm., sessile, glaucous, patent, sometimes twisted towards light; margin entire, pale, slightly stained with pink; surface concave above, convex below; midrib sunken below.

Stem green at first, then pink or brownish; internodes short, about 2 mm. long, do not seem to lengthen, almost glabrous, with a very few scattered hairs and scales.

The variations among the seedlings seem to be slight; one has a 2nd leaf with an emarginate apex, and there is some variation in breadth of leaves and in the pink stain. The variations will be more marked at a later stage. *V. pinguifolia* is essentially a plant of the drier mountains, xerophilous in structure, and not occurring, so far as I know, on the western side of the dividing-range, and possibly not within the region of the western rainfall.

No. 661. **Veronica linifolia**, Hook. f. Plate XXXIV., figs. 52, 53.

Seed gathered from plants growing in shade on wet rocks,

Waterfall Creek, Craigieburn Mountains, by A. H. Cockayne, at altitude of 700 m. Seed germinated in about six weeks.

Description of Seedling.

Plants very small, with stem hidden by the close-set patent shining leaves.

Root descending, fleshy, with very few lateral rootlets.

Cotyledons ovate, 2 mm. long, acute, brownish-green above, pink beneath, furnished with many minute scales; petioles short, subterete, flat or slightly channelled above.

Leaves broadly spathulate, extremely succulent, green, subacute, scaly as cotyledon, patent; petiole two-thirds length of lamina, translucent, subterete, channelled above, connate at base, ciliated on margin with a few transparent hairs.

Stem very succulent, translucent, terete; internodes very short (in plant with three pairs of leaves), 0·75 mm. or less.

Veronica linifolia grows on wet rocks, often in almost perfect shade, in moist river-gorges. The succulent seedling seems rather out of place under such circumstances until one bears in mind that even in a region so wet as the western side of the Southern Alps a drought of a few days makes the ground wonderfully dry, and a plant exposed normally to much wet would suffer extremely unless provided with a water-supply. Figs. 52 and 53, Plate XXXIV., show the differences between the juvenile and adult leaves.

Veronica macroura, Hook. f. Plate XXXIII., figs. 36, 37, 38, 39, 40, 41, 42.

The plant from whose seed the seedlings described below were raised was kindly sent to me some years ago by Mr. T. Kirk, F.L.S., under that name; its leaves, however, do not agree with the description in the "Handbook of the New Zealand Flora," page 207, being ovate or ovate-oblong, almost or quite sessile, and rounded at the base, subapiculate, minutely ciliated; but the slender pubescent slightly curved racemes agree with Hooker's description. Whether it be the true *V. macroura* or not, it reproduces itself quite true from seed, and is most certainly a distinct species.

Description of Seedling.

(Drawn up from self-sown seedling plants in Tarata Garden.)

Root wiry, giving off numerous rootlets equalling the primary root.

Hypocotyle short, terete, minutely pubescent.

Cotyledons oblong, fleshy, entire, obtuse, dotted with minute scales; laminæ 3 mm. × 2 mm.; petioles 2 mm. long, flat, connate at base.

1st pair of leaves fleshy, tender, rotund, rotund-ovate or ovate, obtuse; midrib sunken above, hardly evident beneath; lamina 6 mm. × 5 mm., minutely ciliated, and with a few white scales on the surface; petioles 3 mm. long, subterete, slightly channelled, connate at base.

2nd pair of leaves obovate, entire or lobed, more distinctly ciliated; lamina tapering into petiole, otherwise as first leaves.

3rd pair of leaves similar, but larger, and margin crenate above middle of leaf.

Further development of leaves: The later leaves (Plate XXXIII., figs. 36, 40, 41) become almost sessile, with white midrib above, less distinct beneath, with margin crenate above centre, with shallow lobe at apex, and with base sub-cuneate. These leaves are followed by larger leaves less cuneate at base; these by almost oval sessile leaves, still crenate on upper half of sometimes red-stained margin; and later on still subacute obovate leaves appear.

Stem at first erect, then apex inclines downwards and horizontal branches are developed from the early nodes, terete, at first pinkish, afterwards pale-green, hoary with grey pubescence; internodes (in plant 8 cm. high) 4·5 mm. long.

The development as described above does not as yet show the change into the very distinct adult form (Plate XXXIII., fig. 42).

Veronica diosmæfolia, R. Cunn. Plate XXXII., fig. 26.

Seed gathered from cultivated plant in garden of Mr. W. Martin, Fairfield, Dunedin. Germinated rapidly, and plants are of extremely fast growth.

Description of Seedling.

Root long, wiry, and with numerous long lateral rootlets, especially from base.

Hypocotyle very short, 2 mm. or 3 mm. long, finally very stout and woody.

Cotyledons oblong, entire, slightly emarginate, succulent, pale-green, very short petioled; petioles connate at base.

1st to 3rd pairs of leaves lanceolate, upper half of margin deeply toothed, acute, sometimes dotted on both surfaces with minute white scales, tapering into the petiole; petiole sub-terete, channelled above, one-quarter length of lamina; lamina 6 mm. × 3·5 mm.

4th or 5th pairs of leaves and upwards most uniform in shape, linear- or very narrow linear-lanceolate, almost sessile, convex on upper surface owing to infolding of sides of lamina; midrib evident on upper and under surfaces; margins serrate

above middle, with usually four rather distant teeth; laminæ inclined a little from the horizontal to the vertical.

Stem brown, branching at an angle of about 45°. alternately bifariously pubescent; internodes 3 mm. long; nodes swollen and purple, especially at junction with petiole.

No. 345. **Coprosma acerosa,** A. Cunn. Plate XXXIV., figs. 69, 72.

(Erect var., as found in mountainous situations.)

Seed collected from plant growing amongst other shrubs at base of Mount Earnslaw, Lake Wakatipu. Germination very slow; some of the seeds did not germinate until twelve months from date of sowing.

Description of Seedling.

Root straight, deeply descending, with a few yellow lateral rootlets.

Hypocotyle 4 mm. long, becoming rather longer as plant developes.

Cotyledons 5·5 mm. × 2 mm., narrow linear-oblong, slightly widest near base, obtuse, patent, rather thick and coriaceous; petioles very short; midrib evident below. As the plant developes the cotyledons increase in size, and are persistent until the 6th or 7th leaves appear.

Stem woody, terete, swollen at nodes, with internodes, in plant 4 cm. high, 1st 5 mm. long and 4th 9 mm. long, pale yellowish-brown dotted with red or purple, pubescent everywhere, with numerous very short hairs.

1st pair of leaves 7 mm. or 8 mm. × 2·5 mm., linear-oblong, obtuse, green, brownish on midrib and margin or entirely brownish on upper surface, which has numerous minute scales and a few white hairs in fascicles, paler and scaly on undersurface, obtuse; margins minutely serrulate; midrib evident.

Succeeding leaves much same as 1st pair, often concave above, patent and bending downwards for upper half, but the later leaves are acute, with often a triangular apex, the margins below being quite parallel, green or stained with brown as before.

Stipules: Two, surrounding leaf-bases, interfoliar, connate, triangular, hairy, with from one to three glandular swellings at apex (Plate XXXIV., figs. 72, 69).

Further development: From each axil in the most developed plants a pair of leaves are being developed at right angles to the axis of the earlier leaves.

Variations: The seedlings vary slightly in the amount of pubescence, the purple-stemmed being the most pubescent. In some plants there are slighter broader leaves than those described, and one is subcordate at the base.

The extremely fleshy stipules found in this and all other *Coprosmas* which I have examined, with their glandular swollen tips, seem to be organs of protection for the very young bud, any injury to which would very much check the growth of the plant. Seedlings in the wild state are found most abundantly under the shelter of bushes, especially where there is running water and the adult plants are either constituents of subalpine scrub or occur with other shrubs usually on the shady side of river-terraces. *Coprosma acerosa*, of sand-dunes, and the prostrate river-bed variety, with blue or white fruit, need studying in the seedling form, when it will be found, I think, that they are distinct species. The latter I raised from seed some years ago, and it reproduced itself, but my notes are not full enough for publication.

Coprosma petriei, Cheeseman.

(Var. with white fruit.)

Seed gathered from plants growing on stony flat at Glenorchy, Lake Wakatipu. Germination very slow, but seedlings numerous.

Description of Seedling.

Root very long, 7·5 cm. in plant examined, straight, deeply descending, yellow; rootlets very few, extremely short.

Hypocotyle 4–5 mm. long, terete, suffruticose, lengthening much as development proceeds.

Cotyledons linear, entire, obtuse, covered on upper surface with white adpressed scales, and on under-surface with minute protuberances, gradually narrowing into the short, broad, connate petioles, 8 mm. × 2·5 mm.; soon withers.

Leaves opposite, cauline, stipulate, short-petioled, variable in shape at all stages but all of one type, most common linear-oblong, sometimes narrow-oval, spathulate or linear-obovate, entire, green, thick, fleshy, acute or obtuse, covered on both surfaces with a thin translucent scaly brittle deciduous pellicle, beneath which are abundant minute scaly hairs; midrib obscure, white on under-surface of leaves.

1st pair of leaves 6 mm. × 2 mm., linear-oblong; petiole rather more than half length of leaf.

2nd pair of leaves narrow obovate-spathulate, 9 mm. × 3 mm.; petiole half length of lamina.

Stem pale dotted with pink, terete, swollen at internodes, where it is surrounded by two interfoliar stipules; 1st internode 3 mm., 2nd internode 2 mm. The stem branches laterally from axils of leaves, bearing leaves similar to those described above, except these are very distinctly ciliated on margin with white hairs, and when first developed are spathulate or linear-obovate.

Stipules interfoliar, adnate with petioles, triangular or truncate, furnished with three very short deciduous red glandular hairs at apex, ciliated, rather fleshy at first.

The adult leaves differ considerably from those described above, being narrow-lanceolate, extremely acute, long-petioled, and furnished at regular intervals on both surfaces with stout, acute, erect, white hairs; midrib, margin of leaf, and petioles deeply stained with reddish-brown purple. The seedlings appear to vary very little. *C. petriei* grows in full sunshine, closely pressed to the ground, forming a turf, on old stony river-flats or on stony river-terraces where there is very little earth and exposed to great heat in summer time, at altitudes of from about 300 m. to 700 m., and covering large tracts of ground.

Coprosma areolata, Cheeseman.

Seed gathered from plant at base of Signal Hill, Dunedin. Sown seven months after gathering. Germinated in about ten months.

Description of Seedling.

Root: Primary root straight, descending, very stout, with numerous extremely slender filiform lateral rootlets.

Hypocotyle 1 cm. long, terete, tapering, dotted with purple, glabrous.

Cotyledons oblong, obtuse, dotted with minute scales on under-surface, pale-green, sometimes later on becoming purple-stained, 7 mm. × 3·5 mm. to 9 mm. × 4 mm.; petioles short; midrib evident, pinkish; margins entire, stained with light-purple.

1st pair of leaves: At first almost in same plane with cotyledons, they become gradually raised by lengthening of petioles, while at the same time the apex becomes more acute, and points upwards; 13 mm. × 6 mm., ovate, acute, entire, with red margins and veins, ciliated on margin and midrib; upper surface pale apple-green; under-surface paler than upper; veins much anastomosing; midrib raised on under-surface, especially towards petiole; petiole semi-terete, channelled.

Later leaves very similar to above, but larger; base of leaf tapering into and decurrent with upper part of petiole; upper surfaces, petioles, and margins hirsute with many long, strict, acute, white hairs; upper surfaces of leaves often marked with purple blotches, as indicated in younger leaves by pinkish-purple margins, &c., as described above.

Stem at first very short; cotyledons and 1st pair of leaves appearing to emerge from same spot, gradually lengthening as the 1st pair of leaves develope; then erect, freely budding

and branching from axils of leaves; internodes lengthening considerably as growth proceeds—in plant 5·3 cm. high, 1·1 cm. to 11 mm. long, hairy with short dense pubescence, and also with numerous long acicular white hairs; hairs 1·5 mm. to 2 mm. long, strict, pointing at right angles to axis of stem.

Stipules 2, interpetiolary, adnate, with petioles from broadly triangular to very broadly rectangular, hairy, and furnished at apex with one long fleshy purple mucro.

No. 387. **Aristotelia fruticosa**, Hook. f. Plate XXXI., figs. 16–20a^1–h, and Plate XXXIV., fig. 73.

(Var. with white fruit.)

Seed gathered from plant on Ben Lomond, Lake Wakatipu, at altitude of 400 m. Germination was very slow.

Description of Seedling.

Root brown, flexuous or straight, furnished abundantly with short filiform lateral rootlets, often also with large spreading stout rootlets from base of hypocotyl, nearly equalling the primary root.

Hypocotyle succulent at first, soon stout and woody, finally about 1·5 cm. long, glabrous below, hairy above with adpressed brown hairs.

Cotyledons leafy, persistent for long time, still green on plant 9 cm. high, 8 mm. × 4·5 mm., varying in shape and size, oblong, obovate or oval, obtuse, in one instance retuse, furnished with many minute scales, especially on under-surface, hairy with brown adpressed hairs on the petiole; margins entire, faintly ciliated, especially towards petiole; upper surface dull dark-brownish or yellowish-green; under-surface paler and redder; petioles short, plano-convex, connate at base.

Leaves extremely variable at all stages, even up to the full development of the shrub; early forms of very thin texture, drying up rapidly if exposed to drought, green, brown, blackish-green or reddish-brown on upper surface; of similar tints but paler and more shining on under-surface; shape most variable; first few leaves usually ovate to lanceolate (Plate XXXI., figs. 14, 18); later leaves linear-lanceolate to broad-lanceolate, at times narrow-triangular (Plate XXXI., figs. 15, 19, 20, and Plate XXXIV., fig 73); still later leaves* (Plate XXXI., figs. 20*a*, *b*, *g*, *h*) obovate, obovate-oblong, cuneate at the base, entire, slightly or much serrate, with intermediate most curious forms by reversion, linear-lanceolate, serrate or pinnatifid, with segments linear or linear-oblong,

* From wild seedling in cultivation for eight months.

sometimes pectinate; serrations and sides of leaves often much incurved; colour of later leaves often almost black, very dark-brown or dull-green in centre, surrounded by dark margin; margins (of earlier leaves) rarely regularly serrate, usually irregularly biserrate, ciliated; midrib much raised on under-surface, hairy; venation penninerved and reticulating, with veins often much swollen on under-surface of leaf; petioles subterete, variable in length, slightly channelled, connate at base.

Size of leaves: This may be seen from the figures in the plates, which are natural size. In the older plants some of the leaves are considerably larger than those figured.

Stem (in young seedlings) erect, straight, usually pink in early seedling, in older seedlings much darker, almost black at times, with very dark-purple blotches, pubescent with short straight hairs sometimes curving upwards at the tip; internodes averaging about 8 mm. long in plants 6 cm. high; in older seedlings (the tallest 24 cm. high) are stout, straight, horizontal branches at right angles to main axis, sometimes opposite, sometimes alternate, with leaves like those on main axis opposite and sometimes with surface quite flat and exactly horizontal.

Final development into mature state with more simple reduced leaves (Plate XXXI., figs. 16, 17) not yet observed.

The various forms assumed by the leaves of *A. fruticosa* are almost beyond belief; still a regular sequence of forms from the early thin-leaved ovate to the later coriaceous obovate by way of all varieties of lanceolate can be traced. Perhaps the most remarkable of all are the narrow lanceolate or triangular forms with truncate bases (Plate XXXIV., fig. 73), observed in the collected seedlings, which were reverting to the lanceolate early seedling form (Plate XXXI., fig. 15). At this stage the leaves often assume a considerable size (Plate XXXI., fig. 20), and in many instances are incised almost to the midrib. The early red-stemmed ovate-lanceolate leaved seedling much resembles *A. racemosa* and *A. colensoi* in miniature, and these latter may be looked upon as plants arising from a common ancestral stock which have kept almost intact the ancestral character, whereas in *A. fruticosa* this has been entirely changed by its subalpine environment. It is true that *A. colensoi* and *A. racemosa* also at times reach the subalpine zone, but it is in places where they have abundant shelter and moisture. The final form of *A. fruticosa* becomes very similar to that of its companion plants referred to before when treating of *Pittosporum rigidum*; and, with its dense rigid tortuous branches and small coriaceous leaves, it might well be taken for *A. coprosma*. In the wild state very

many adult forms of *A. fruticosa* are met with, many of which must depend upon the local environment, and which will be possibly of the most unstable character.

No. 389. **Plagianthus divaricatus**, Forst. Plate XXXI., figs. 9^1, 10, 11.

Seed collected from plant growing in salt meadow near New Brighton, Canterbury. Germination very rapid, from eight to fourteen days.

Description of Seedling.

Root fleshy, straight, tapering, descending, pale, with few very short lateral rootlets.

Hypocotyle terete, glabrous, tapering upwards from the thickened base, slightly twisted or bent, white below, pale-green above.

Cotyledons from subcordate to almost rotund, 3- or 5-nerved, with much reticulated venation, sometimes slightly lobed or angled towards apex, minutely glandular-pubescent; petioles subterete, slightly channelled, almost equalling the lamina.

Leaves alternate, stipulate.

1st leaf broadly ovate, almost glabrous, entire or marked with slight notch towards the somewhat abrupt narrowing of the apex; petioles channelled, half length of lamina.

2nd leaf oblong to broadly oblong; margins marked with one or two crenations, forming three irregular lobes.

3rd leaf similar in shape, but more narrow than 2nd leaf.

Later development of leaves: The succeeding leaves become more narrow, for a time each leaf a little narrower than its predecessor, until (Plate XXXI., fig. 11) the usual form is linear-lanceolate with petiole half length of lamina, pale-green, nerves faintly swollen on upper surface, and sometimes falcate in shape.

Stem at first wiry, brown, terete and straight, then becoming flexuose and extremely pliant as development proceeds, still very slender, especially towards slightly drooping extremity; hairy with minute white stellate hairs; thickened at nodes, whence arises one oblong or triangular, truncate at apex, very hairy stipule; branching at rather distant intervals with long divaricating branches similar to main axis, also with very short branches with suppressed internodes and leaves in fascicles.

P. divaricatus is finally a rounded, most dense shrub, with interlacing, short, stout, pliant, much-divaricating branches bearing many small linear or obovate-linear falcate sessile leaves, usually in fascicles. On the outside of the shrub these leaves are extremely fleshy, and often have the dorsal surface

turned to the incident light, but inside and sheltered are much thinner. Younger plants have the upper twigs erect, not interwoven, and have stellate hairs, as in the seedling form, but extremely reduced fleshy linear leaves. It grows in wet salt meadows, near the sea-shore, and is exposed to most frequent east winds, and when these do not blow to heavy gales from north-west and south-west. This constant exposure to wind accounts for the final habit of growth, which much resembles that of *Coprosma acerosa,* growing on the adjoining sand-dunes. It is interesting in connection with the above that *P. linariifolia,* Buchanan, of the West Coast, from moister and probably more sheltered habitat, is, judging from his drawing and description (Trans. N.Z. Inst., vol. xvi., pl. xxxiv., pp. 394, 395), much more like the later seedling form of *P. divaricatus* than is its own adult form.

Pseudopanax crassifolia, C. Koch. Plate XXXIII., figs. 31–35.

Described from seedlings collected on bank of River Kowai, Mount Torlesse Range, and which have been cultivated in greenhouse under same conditions as other seedlings treated of for eight months.

Description of Seedling.

Root long, stout, often with many lateral spreading rootlets from the base; young rootlet with great numbers of root-hairs.

Hypocotyle variable in length, thick, fleshy at first, then woody, dark-brown or dark-purple, glabrous, smooth, terete.

Cotyledons persistent, leafy, obovate (fig. 33), oblong, entire or toothed, rounded obtuse or very shallow-lobed at apex; midrib prominent, swollen; margin pale-reddish, slightly recurved; petioles short, semi-erect, connate at base.

1st leaf coriaceous, dark-green, often blotched with pale-brown, ovate-lanceolate, cuneate at the base or rhomboid, deeply and coarsely toothed, tapering gradually into the petiole; petiole semi-terete, channelled above, half length of lamina, sheathing and swollen at the expanded base.

2nd leaf usually linear-lanceolate, sharply toothed; teeth largest towards base of leaf; apex acute: surfaces—upper, black-green, spotted with pale-brown; under, much paler, tapering into the petiole: midrib evident on both surfaces, and raised; petiole semi-terete, slender, channelled, much shorter than lamina, sheathing and swollen at base.

3rd leaf often very similar to 2nd, or already the second type of leaf may have appeared as under.

4th and next few succeeding leaves sessile, or almost so, spreading and pointing slightly upwards, linear, with distant

regular alternate short stout teeth (quite different from the coarse serrations of the first type of leaf), with yellowish rather blunt tips and their bases on upper surface of leaf slightly swollen; upper surface very dark-green, often marked with pale-brown blotches, especially along midrib and bases of teeth; under surface paler than upper, and brown on midrib and round margin; midrib very prominent, raised and reddish-yellow on upper surface; petiole or base of leaf expanding into amplexicaul sheath slightly swollen.

Stipules subulate, membranous, adnate to leaf-sheath at base.

Stem erect, often bent or twisted, stout, woody, brownish, marked with many oblong or round white blotches; internodes very much reduced above, longer below; several of the seedlings under examination 4·5 cm. high are already branching from near apex of primary stem.

The further development has been treated of at considerable length by Kirk ("Forest Flora," pp. 59, 60; and Trans. N.Z. Inst., vol. x., Appendix, pp. xxxi. to xxxiv.). He shows that there are various varieties of *P. crassifolium*, and that some of these have distinct and constant seedling forms, while one, the form of the Chatham Islands, never passes through the long-leaved seedling form of which my description above is but a preliminary stage. If there are several seedling forms distinct from one another except in the very earliest stage, then I should certainly think, from biological grounds, that there are as many species as there are distinct seedling forms. The matter is certainly one which needs going into again from a specific point of view, to say nothing of the immense interest attached to any facts that might be elicited in regard to the conditions which cause the various leaf-changes. It would, I think, be easy to cause an adult to revert to the juvenile form simply by cutting down a tree or removing a considerable limb, when the new growth would be the juvenile most likely. Cuttings of the mature form could also be struck, and, when rooted, experimented with under various known conditions. Botanists in the North Island, where the var. *trifoliata* is to be found, might easily undertake this interesting work. Kirk says, "The stem is invariably simple in this stage of development, ranging from 6 ft. to 20 ft. in height before branching"; but in my seedlings, grown in moist greenhouse, &c., they are already branching, as stated above.

No. 326. **Olearia odorata,** Petrie. Plate XXXIII., fig. 43.

Seed collected from shrub growing in Waitaki Valley by Mr. Rutherfurd, Rugged Ridges. Germination slow.

Description of Seedling.

Root extremely stout, tapering, deeply descending, with lateral rootlets mostly from upper half.

Hypocotyle very short, subterranean, hardly to be distinguished from the root.

Cotyledons wither very early, rotund, petiolate. (Too much withered for further description.)

Leaves at first crowded together, appearing almost radical through the slow development of the internodes, afterwards becoming much more distant; appear to increase considerably with growth of plant for some time; opposite, short-petioled, spreading, patent, from ovate-oblong to spathulate, pale whitish-green, entire, in one specimen slightly lobed, furnished with many minute scales on both surfaces, and with numerous adpressed hairs on petioles, midribs, and bases of laminæ, but more sparingly hairy on surfaces and margins; laminæ narrowing very gradually into petioles; petioles partly sheathing, and connate at bases. The more early developed leaves are much broader than the later ones. Measurements —Early leaves, 2·5 cm. × 1 cm.; later leaves, 1·10 cm. × 5·5 mm.

Stem erect, terete, stiff, rather densely covered with adpressed white hairs, purple and swollen at the nodes, forming leaf-scars when leaves are shed; internodes, in plant 5·4 cm. high, 11 mm. long.

Further development not yet observed.

No. 427. **Gunnera dentata**, Kirk. Plate XXXIV., fig. 48.

Seed gathered from plants growing on very wet clay bank, near Glenorchy, Lake Wakatipu. Germination very slow. Very few seeds germinated, and seedlings of extremely slow growth.

Description of Seedling.

Root thick, fleshy, rather short; afterwards from stem appear fusiform adventitious rootlets, with bright, shining, crimson tip, and furnished with very many extremely slender root-hairs near the base, these at first aerial.

Hypocotyle short, semi-prostrate, very pale-green, sparsely hairy with straggly hairs.

Cotyledons very pale-green, 6 mm. × 2 mm. to 4 mm. × 2 mm., spathulate, extremely fleshy and succulent, with a few long pale hairs and many minute scales, convex on upper flat on under surface, spreading, with surface almost horizontal.

1st leaf 5 mm. × 3·5 mm., almost rotund in outline, fleshy, truncate at base, entire for lower half of margin, and coarsely serrate, with two opposite teeth on upper half, and sparingly hairy; apex lobed, acute; upper surface of

lamina marked with numerous minute scales and with a few straggling long twisted hairs; under-surface of lamina with stout midrib and indistinct veins, more hairy than upper surface; petioles very stout, sheathing and connate at base, brownish-green, pilose.

2nd leaf rounded at base, more toothed than 1st leaf.

3rd, 4th, and 5th leaves often more narrow than the 1st and 2nd, obovate or oblong, with toothing less coarse and apices of teeth thickened, lamina sometimes tapering at base into the petiole, petiole as long or nearly twice as long as lamina, channelled above, sheathing beneath.

Stem (in plants with five leaves, the largest examined) very short, thick and fleshy, sometimes with internodes almost suppressed, giving off adventitious roots, which first appear as crimson protruberances, hairy as leaves.

Further development not yet observed.

The material from which the above was drawn up was not good, and so the description may not be strictly accurate; also, details of interest may have been left out. It is possible the earliest leaves may sometimes be much narrower and less toothed than the one figured. The species grows most luxuriantly on banks of sluggish streams in mountainous districts, also on wet banks or on rock in the drip of water. The young plants examined had extensive colonies of *Nostoc* in the parenchyma of the stem just at the lower-leaf bases.* Between the adult and juvenile forms there seem to be no very great differences.

No. 416. **Hymenanthera dentata**, R. Br., var. *angustifolia*, Benth. Plate XXXIII., figs. 44–47.

Seed collected at Kingston, Lake Wakatipu. I am not sure of the correctness of my identification, not having seen the type specimens in Kirk's herbarium. It is, however, one of the forms called by Hooker, in the "Handbook of the New Zealand Flora," *H. crassifolia*, and it is also the plant under that name in Petrie's "List of Otago Plants" (Trans. N.Z. Inst., vol. xxviii., p. 543).

Description of Seedling.

Root long, descending deeply, thick, with many lateral rootlets.

Hypocotyle: One half subterranean, very fleshy at first, then woody, pale-coloured, finally pinkish, often bent, terete, glabrous.

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* I am indebted to Dr. K. Goebel for showing me *Nostoc* in *G. monoica*, and so calling attention to the fact that New Zealand *Gunnera*, as well as South American, possess *Nostoc* colonies.

Cotyledons 1·1 cm. × 7·5 mm., oblong, oval or rotund-oblong, entire, retuse or emarginate, rarely obtuse, thick, coriaceous, very persistent, dull dark-green, with many minute scales, especially on the under-surface, 3-nerved from base; midrib on entrance into leaf almost immediately giving off two more nerves, which are parallel for a time, and then converge towards apex of leaf; petiole very short, subterete, flattened above, 2 mm. long.

Early leaves alternate, stipulate, variable in shape, often from oblong to linear-oblong, blackish-green on upper paler on under surface, short-petioled or sessile; midrib and veins swollen on upper surface, indistinct on under-surface, dotted with many minute white scales; margins entire or serrate; serrate margins with serration on one side, with one opposite serration on each side, usually nearer base than centre; apex lobed to subacute.

Later leaves pale-green at first, linear to linear-oblong, tapering into very short petiole, smaller than earlier leaves on main stem, usually entire, with very short apiculus at end of midrib, sometimes lobed and irregularly toothed as in early leaves; veins swollen on upper surface; laminæ at angle of 45° to axis of stem, semi-vertical to horizontal.

Stipules very small, one on each side of petiole, subulate.

Stem of slow growth, very stiff, erect, and woody, early branching with stiff divaricating branches, rather pale-brown, with many flat white scales at regular intervals, younger portions of branches with two rows of very short close-set hairs, terete; internodes 3 mm. long, more or less.

Further development not observed.

In one or two instances the laminæ of the cotyledons were partly or very nearly cleft to the base, showing how a plant may be developed with more than the normal two cotyledons. The toothing on the leaves seems due to non-development of the nerve and accompanying portion of lamina rather than to ordinary toothing, the two lateral nerves of a trinerved leaf ending in this case in the serrations, the midrib alone reaching the upper portion of the leaf. *Hymenanthera dentata* is another of the shrubby plants which grow under conditions of drought and wind, and its final adult stage resembles that of *Coprosma acerosa*, &c., treated of before.

No. 665. **Celmisia bellidioides**, Hook. f.

Seed collected by A. H. Cockayne at Waterfall Creek, Craigieburn Mountains, at altitude of 1,200 m., growing on wet rock, in shade. Germination slow.

Description of Seedling.

Hypocotyle 6 mm. long, brittle, rather thick.

Cotyledons 5 mm. × 2·75 mm., linear-oblong, obtuse, sessile, unequal in size, thick, coriaceous, glabrous.

Leaves imbricating, with broad sheathing bases, matted together at base with long cobwebby white hairs.

3rd leaf: Lamina narrow-oblong, 5 mm. × 3·5 mm., one tooth on one side, rest of margin entire, obtuse, varnished green on upper surface, paler on under-surface, tapering into the long petiole; petiole 5 mm. long, broader at base, sheathing and imbricating with other petioles.

Next few leaves very similar.

Further development not yet observed.

It is only the extreme difficulty of raising such a *Celmisia* as this from seed, and the further difficulty of keeping the seedlings alive when raised, that decided me to give the above meagre description.

Veronica armstrongii, Hook. f.

The seedling plant referred to in Part I., and of which a photograph is appended (Plates XXVIII. and XXIX.), was, for purpose of photographing, taken out of its small pot, and then repotted in a larger one, in the middle of October, 1898. The plant was kept until the middle of December in the greenhouse, along with the other seedlings, by which time the tips of the shoots in nearly every instance were beginning to approach nearer to the adult scaly adpressed form. The plant was then placed under a bell-glass and kept very moist, to see if under such conditions it would again revert to the seedling form. The experiment has been eminently successful, and now—February, 1899—every shoot is well furnished at the tip with seedling leaves, which are 4 mm. long, petiolate, linear-lanceolate, deeply toothed, with two opposite teeth on each side, one tooth or the older leaves entire, bright-green, soft and succulent; petioles broad, connate; midrib evident. The smaller more-reduced leaves further down the stem have also opened out considerably, and their upper portion is quite patent. The plant is in good health, and growing vigorously. The shoots are leafy and green for their whole length, and the plant in its present state much more resembles *V. loganioides*, Armstg., than its own adult form. I am going to keep it under the same conditions, to see if it is not possible to bloom it while in this still juvenile form. The plant is now 13·6 cm. tall and 10 cm. in diameter, with branches opposite and quadrifarious.

EXPLANATION OF PLATES XXVIII.-XXXIV.

Plate XXVIII.

Branch of *Veronica armstrongii*, T. Kirk. Photographed from cultivated specimen.

PLATE XXIX.

Seedling plant of *Veronica armstrongii*, two years old, and portion of shoot cut from same.

PLATE XXX.

Fig. 1. Later leaf of seedling *Carmichælia gracilis*.
Fig. 2. Seedling plant of *C. gracilis*.
Fig. 3. Seedling plant of *Veronica salicifolia*.
Fig. 3*a*. Third seedling leaf of *V. salicifolia*.
Fig. 3*b*. First seedling leaf of *V. salicifolia*.
Fig. 4. Seedling plant of *Pittosporum rigidum*.
Figs. 5, 5*a*. Later leaves of *Carmichælia robusta* (?).
Fig. 6. Leafy cladode of *Carmichælia hookeri*.
Fig. 7. Seedling plant of *C. hookeri*, showing the later leaves.
Fig. 8. Early seedling form of *C. hookeri*.
Fig. 9. Early seedling form of *C. robusta* (?).

PLATE XXXI.

Fig. 9^1. Seedling plant of *Plagianthus divaricatus*.
Fig. 10. Cotyledon of *P. divaricatus*.
Fig. 11. Later seedling leaf of *P. divaricatus*.
Fig. 12. Seedling plant of *Carmichælia crassicaule*.
Fig. 13. Portion of leafy cladode from adult *C. crassicaule* developed in cultivation.
Fig. 14. Seedling plant of *Aristotelia fruticosa* (cultivated).
Fig. 15. Later seedling leaf of *A. fruticosa* (cultivated).
Figs. 16, 17. Leaves from adult *A. fruticosa*.
Fig. 18. Early seedling leaf of *A. fruticosa* (cultivated).
Fig. 19. Later seedling leaf of *A. fruticosa* (cultivated).
Fig. 20 (a^1 to *h*). Various forms of seedling leaves of *A. fruticosa* from wild seedling plants.

PLATE XXXII.

Fig. 21. Seedling plant of *Rubus australis*, var. *glaber*.
Fig. 22. Seedling plant of *Pseudopanax crassifolia* (wild).
Fig. 23. Seedling plant of *Veronica obovata*.
Fig. 24. Seedling plant of *Carmichælia odorata*.
Fig. 25. Seedling plant of *Sophora microphylla*.
Fig. 26. Seedling plant of *Veronica diosmæfolia*.
Fig. 27. Seedling plant of *Veronica traversii*.
Fig. 28. Early seedling form of *V. traversii*.

PLATE XXXIII.

Fig. 30. Leafy cladode of seedling *Carmichælia robusta* (?).
Fig. 31. Fifth seedling leaf of *Pseudopanax crassifolia*.
Fig. 32. Seedling plant of *P. crassifolia*, showing cotyledons.
Fig. 33. Cotyledon of *P. crassifolia*.
Fig. 34. Second leaf of *P. crassifolia*.
Fig. 35. First leaf of *P. crassifolia*.
Fig. 36. Later seedling leaf of *Veronica macroura*.
Fig. 37. Seedling plant of *V. macroura*.
Fig. 38. Second or third leaf of seedling *V. macroura*.
Fig. 39. First or second seedling leaf of *V. macroura*.
Figs. 40, 41. Later leaves than No. 36 of *V. macroura*.
Fig. 42. Adult leaf of *V. macroura*.
Fig. 43. Seedling plant of *Olearia odorata*.
Fig. 44. Seedling plant of *Hymenanthera*, species.
Figs. 45, 46. Early seedling leaves of *Hymenanthera*.
Fig. 47. Later seedling leaf of *Hymenanthera*.

PLATE XXXIV.

Fig. 48. First seedling leaf of *Gunnera dentata*, × 6.
Fig. 50. First seedling leaf of *Ozothamnus depressus*, × 6.
Fig. 51. Cotyledon of *Ozothamnus depressus*, × 6.
Fig. 52. Adult leaf of *Veronica linifolia*, × 1.
Fig. 53. First seedling leaf of *V. linifolia*, × 6.
Fig. 55. Early leaf of *Veronica tetrasticha*, × 6.
Fig. 56. Adult leaf of *V. tetrasticha*, slightly changed by moist shady atmosphere, × 4.
Fig. 57. Adult leaf of *V. tetrasticha*, almost reverted to seedling form, × 4.
Fig. 58. Adult leaf of *V. tetrasticha*, intermediate between Nos. 56 and 57.
Fig. 59. Later seedling leaf of *V. epacridea*, × 6.
Fig. 60. Second seedling leaf of *V. epacridea*, × 6.
Fig. 61. Second leaf of *Veronica pinguifolia*, × 6.
Fig. 62. First leaf of *Veronica traversii*, × 4.
Fig. 63. Adult leaf of *V. pinguifolia*, × 1.
Fig. 64. Late seedling leaf of *V. pinguifolia*, × 1.
Fig. 65. Adult leaf of *V. epacridea*, flattened out, × 1.
Fig. 66. Emarginate (abnormal) cotyledon of *V. traversii*, × 6.
Fig. 67. Glandular hair of *Rubus australis*, × 268.
Fig. 68. Hairs of *Rubus australis*, × 268.
Fig. 69. Glandular tip of stipule of *Coprosma acerosa*, × 50.
Fig. 70. Fifth seedling leaf of *Sophora* (Chatham Island var.), × 1.
Fig. 71. Fifth seedling leaf of *Sophora grandiflora*, × 1.
Fig. 72. Stipule of *Coprosma acerosa*, × 6.
Fig. 73. Leaf of wild seedling *Aristotelia fruticosa*, changed by conditions of cultivation, × 1.

ART. XXXIII.—*On the Burning and Reproduction of Subalpine Scrub and its Associated Plants; with Special Reference to Arthur's Pass District.*

By L. COCKAYNE.

[*Read before the Philosophical Institute of Canterbury, 4th May, 1898.*]

Plates XXXV.–XXXVII.

UP to the present time no scientific account of the effect of fire on New Zealand vegetation, illustrated by accurate observations, has been published. From time to time generalised statements, founded on slight or insufficient data, have appeared in the "Transactions of the New Zealand Institute" and elsewhere. Thus, for instance, the Rev. P. Walsh writes*: "Nature makes a brave effort to reclothe the hills and gullies of New Zealand in her verdant mantle, and if let alone would bring her work to completion. Under favourable circumstances seedling trees soon make their appearance, and if

* "On the Disappearance of the New Zealand Bush," by the Rev. P. Walsh (Trans. N.Z. Inst., vol. xxix., p. 496).

protected from injury would in due time attain to maturity. Of course, anything like a real restoration of the original bush is out of the question, but the second growth has a beauty of its own, which is by no means to be despised. . . . It is interesting to notice that everywhere the trees which are characteristic of the locality are not long in making their appearance."

The late Mr. T. Kirk, F.L.S., has gone into the matter with somewhat greater detail.* "On the west coast of the South Island," he writes, "much of the New Zealand forest, when burnt off, is temporarily replaced by a robust growth of a large native groundsel (*Erechtites prenanthoides*, DC.), which often attains the height of 5 ft., most of it disappearing before the close of the third year, when its place is taken by fern, or more rarely by shrubs and trees"; and, regarding a fire in the Hope Valley, he states: "The burnt area on each side of the road-line was thickly dotted with the rare pine, *Podocarpus acutifolius*, T. Kirk, although very few specimens of the plant were to be seen in the immediate vicinity"; and he concludes his remarks thus: "Much, however, has yet to be learned with regard to phenomena of this kind in New Zealand."

During a stay of six weeks' duration this summer—December, 1897, and January, 1898—on the summit of Arthur's Pass, I was enabled to take the fairly copious notes embodied in this paper on the effect of two fires which had devastated the vegetation of that locality, the one a recent and the other a burning of more distant date. Such notes will, I think, tend to show what would be the ultimate results of fires in localities similar to Arthur's Pass, to such, indeed, on the western side of the dividing-range, or on the eastern within the limits of the heavy western rainfall and its accompanying misty weather.

Regarding the first fire, I can give no exact date; possibly it took place twenty or more years ago, or there may have been several fires during the period that the pass has been used for traffic. But of the recent fire more exact information is to hand: it took place in the year 1890, and was the work of the Midland Railway survey. This fire, originating somewhere on the left bank of Peg Leg Creek, near its junction with the Otira River, crossed that river and ascended the Westland spur of Mount Rolleston to a height of 1,000 m. or more, while on the Arthur's Pass side it followed the Otira River for about 1 kilom. towards its source; also, spreading round the Canterbury spur of Mount Rolleston, it ascended

* "The Displacement of Species in New Zealand," by T. Kirk, F.L.S. (Trans. N.Z. Inst., vol. xxviii., p. 16).

that mountain almost to the limit of the shrubs at 1,200 m., finally burning the whole of the shrubby vegetation on the more level portions of the pass—in places crossing the road—except a few patches here and there, as far as the *Fagus* forest in its south-west corner, the outskirts of which were in places destroyed. It is also quite possible that this same fire was responsible for the burning of most of the vegetation on the Canterbury side of Hill's Peak. Previous to the last fire or fires the whole of Arthur's Pass except swamps and ground liable to flood was covered by more or less dense subalpine scrub. This subalpine scrub, or dense mass of rigid branching shrubs, is one of the most noteworthy features of New Zealand vegetation, and has always been made a subject of considerable comment by New Zealand explorers and the like. The Rev. W. S. Green thus wrote of it: * "There were a number of other bushes with strong gnarled stems and small leaves"; these "combined to form as ungetthroughable an obstacle as it was possible to imagine." Haast also speaks of such shrubs as "impenetrable scrub," and, writing of Mems Knob, he says,† "For botanical purposes I returned to the foot of the hill through the bush, a herculean task, particularly for one of portly dimensions, as we had often to lie flat on the ground and crawl through or walk over the tops of the branches." T. Kirk describes‡ graphically a similar scrub on Mount Anglem, Stewart Island; and Dr. Diels, in his recent work on the biology of New Zealand plants,§ treats of this subalpine scrub at some length.

The subalpine scrub occurs usually just above the forest-line, at first intermixed with the forest-trees and afterwards forming a distinct belt and barrier between the forest and the grass-line for a varying distance, and ending usually at 1,000 m. to 1,200 m., or even higher. Such scrub occurs more or less on all the high mountains; but on the dryer ones—such as those of Central Otago, East Nelson, Marlborough, or the eastern portions of the Southern Alps—not forming a distinct belt, but only patches in places. Its tendency to burn is well exemplified by the local name, "turpentine scrub." Growing in association with this scrub, in places where it is not too dense, and especially towards its highest altitudinal limit, are the most striking herbaceous plants

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* "The High Alps of New Zealand," by the Rev. W. S. Green. London, 1883.

† "Report of the Head Waters of the River Rakaia," by Julius Haast, Ph.D. Christchurch, 1886 (page 20).

‡ "On the Flowering-plants of Stewart Island," by T. Kirk, F.L.S. (Trans. N.Z. Inst., vol. xvii., p. 220).

§ "Vegetations-Biologie von Neu-Seeland," von L. Diels. Leipzig, 1896 (pp. 261–263).

of our flora. The scrub itself, too, consists in the main of beautiful flowering-shrubs, a great number of which are now favourite garden plants in many parts of the world. Should this subalpine scrub be set on fire during a dry season very large areas will be burnt to the ground, and, except in some few protected spots, apparently completely destroyed, together with the contained herbaceous plants and grasses. When it is borne in mind that musterers light fires promiscuously on the mountains to show their whereabouts to their fellow-workers, it may readily be seen that, unless nature does something towards its replacement, this most interesting feature of the New Zealand flora bids fair to become a thing of the past. That nature does not replace this loss is at the present time the commonly received opinion. Mr. A. Harper, in his work on the Westland Alps, makes the deliberate statement* that "the scrub never grows again when burnt," and consequently he set fire to various patches, so as to provide an easy route up the mountains in time to come. That this statement is not in accordance with facts will be seen from the results of my investigations, as stated at the close of this paper.

The flora of Arthur's Pass and its vicinity may be naturally divided into two sections—eastern and western—the differences between which can be at once perceived even by the untrained eye, the eastern being more lowly in growth than the western, and having as near neighbour a *Fagus* forest, while the western is much taller, greener, and more luxuriant. Here *Fagus* is entirely absent, while *Dracophyllum traversii*, a most remarkable Epacrid, forms conspicuous clumps. This difference is one of habit and percentage of component parts rather than of great difference in species, the dominant shrubs of the western not always being the same as those of the eastern division.

After making a general examination of the whole, certain spots suggested themselves as eminently suitable for determining—first, the nature of the former vegetation; and, second, the plants which had appeared since the more or less complete destruction of the original scrub. These spots all contained patches of considerable size which the fires had completely spared, some belonging to the Midland Railway fire and others to that of earlier date. Each spot or section, as I propose to call it, I examined carefully, making, with regard to the living scrub, a list of its species, noting their height, the quantity or proportion of each species, the seedlings growing under their shade, with the quantity and size of such

* "Pioneer Work in the Alps of New Zealand," by Arthur P. Harper, B.A. London, 1896.

seedlings. With regard to the adjacent burnt portions, I made lists of seedling plants, their size, their number in a stated area, and their numbers with regard to each other; noted also those plants which were only killed to the ground, and had come up from the old stock, and those also which escaped the fire altogether. In one instance, also, I added to my list all the introduced species not indigenous which had made their appearance.* Some attention was also given to variation of seedlings growing under the new conditions of light and moisture, but such I reserve for consideration elsewhere. The various sections, being mostly easy of access, are readily available for future observations, and the struggle for survival between the present small plants can easily be watched and recorded by any future observer.

Section A comprises the country at the Canterbury end of the pass in the vicinity of the Pass Creek, on both sides of the West Coast Road. Near the *Fagus* forest, reaching to the edge of the creek, is a piece of unburnt scrub, while another piece lies just over the main creek, on its northern side and close to the road. With regard to the burnt portion, there is a fine example for investigation between the two branches of the creek. The following list is drawn up from notes on these portions, and written on the spot, as were, indeed, all the notes from which this paper is made up:—

FORMER CONSTITUENTS OF SECTION A (arranged roughly in order of greatest quantity).

1. *Dracophyllum longifolium*, Br.; covering half the area, 1·35 m. in height.
2. *Phyllocladus alpinus*, Hook. f.; forming nearly one-sixth of the whole.
3. *Gaya lyallii*, Jack. and Hook.; abundant, especially near the forest; 4 m. to 6 m. in height.
4. *Panax colensoi*, Hook. f.; 1·35 m. in height.

5. *Coprosma cuneata*, Hook. f. 6. " *parviflora*, Hook. f. 7. *Veronica odora*, Hook. f. 7A. " *subalpina*,† sp. nov. 8. " *canterburiensis*, J. B. Armst.	Scattered or in clumps here and there, but in no great quantity.

9. *Cassinia vauvilliersii*, Hook. f.
10. *Coprosma ramulosa*, Petrie.

* In most of the sections this was not necessary, for introduced plants take little or no place.

† This *Veronica* is the most abundant form in Westland, to the exclusion of all others except *V. salicifolia* at a certain altitude. Mr. T. Kirk, to whom I referred a specimen, named it *V. traversii*, var. approaching *V. lævis*. I think, however, it is as good a species as most of our *Veronicas*, varying to no great extent, and occupying wide areas. I therefore propose to call it provisionally "*Veronica subalpina.*"

11. *Coprosma serrulata*, Hook. f.
12. *Myrsine nummularia*, Hook. f.
13. *Senecio bidwillii*, Hook. f.
14. *Pittosporum rigidum*, Hook. f.
15. " var. with white flowers.
16. *Dracophyllum uniflorum*, Hook. f.
17. *Aristotelia fruticosa*, Hook. f.
18. *Coprosma*,* sp. with ciliated leaves.

Beneath the dense portion of the above scrub grew very few herbaceous plants and grasses, but, where thinnest, *Aciphylla colensoi*, Hook. f.; *Phormium cookianum*, Le Jolis; *Erechtites glabrescens*, T. Kirk; *Hierochloe alpina*, Rœm. and Schl.; *Danthonia raoulii*, Steud.; various *Epilobiums*; and possibly many other plants either not growing under the present living scrub or unnoticed by me (Plate XXXV.).

Ferns were represented by *Lomaria alpina*, Spreng.; *Lomaria procera*, Spreng.; and *Hypolepis millefolium*, Hook.

Where the height of the scrub is not stated above, the average would be perhaps from 1 m. to 1·5 m.

SEEDLINGS UNDER UNBURNT PORTION OF SECTION A.

(1.) *Under* Phyllocladus.

Aristotelia fruticosa, Hook. f.; 0·07 m. in height.
Coprosma parviflora, Hook. f.
Olearia nummularifolia, Hook. f.
Pittosporum rigidum, Hook. f.; quite small; only developed to its fourth leaf.

All these were growing in considerable quantity in the decayed leaves and matted roots, which form a moist soil for a depth of 0·06 m.

(2.) *Under* Podocarpus nivalis, *Hook. f.*

Nil.

(3.) *Where Sunlight can partially penetrate.*

Veronica canterburiensis, J. B. Armst.
Gaya lyallii, Hook. and Jack.
Panax colensoi, Hook. f.

(4.) *Where the Scrub is dying out with Old Age.*

Panax colensoi, Hook. f.
Veronica canterburiensis, J. B. Armst.
Dracophyllum longifolium, Br.
Veronica subalpina, mihi (ined.).
Panax anomalum, Hook. f.
Many of these seedlings are 0·33 m. high.

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* This may be a ciliated var. of *Coprosma parviflora*, Hook. f., as indicated by Cheeseman, or it may be quite possibly an undescribed species.

Section A.—Plants which have appeared in the Burnt Portion since the Fire.

The locality specially examined lies between the two branches of the creek, and on Hill's Peak side of West Coast Road.

(1.) *Shrubs.*

Cassinia vauvilliersii, Hook. f.; in quantity.
Veronica odora, Hook.; plentiful where ground is wet.
Coprosma parviflora, Hook. f.; in large quantity.
Gaya lyallii, Hook. and Jack.; growing from old stump.
Aristotelia fruticosa, Hook. f.; in quantity.
Veronica canterburiensis, J. B. Armst.; in large quantity.
Coprosma serrulata, Hook. f.; seedling plant (?).
" *acerosa*, A. Cunn., var.; in quantity.
Veronica subalpina, sp. nov.; in large quantity.
Coprosma cuneata, Hook. f.
" sp. with ciliated leaves.
Gaultheria antipoda, Forst.
Coprosma ramulosa, Petrie; seedling (?).

(2.) *Other Phanerogams.*

Epilobium nummularifolium, A. Cunn.
" sp. allied evidently to *E. glabellum*, Forst.
" *pubens*, A. Rich.
Acæna sanguisorbæ, Vahl, var.
" *glauca*, sp. nov. (ined.).
Phormium cookianum, Le Jolis.
Luzula campestris, DC., var.
Festuca duriuscula, L., var.
Ranunculus lyallii, Hook. f.
" *plebeius*, Br.
Celmisia armstrongii, Petrie.
" *coriacea*, Hook. f.
" *spectabilis*, Hook. f.
" *longifolia*, Cass., var.
" *flaccida*, sp. nov.
Hierochloe alpina, Rœm. and Schultz.
Danthonia pilosa, Br.
Geranium microphyllum, Hook. f.
Wahlenbergia saxicola, A. DC.
Veronica lyallii, Hook. f.
Euphrasia cockayniana, Petrie.
Erechtites glabrescens, T. Kirk.
Pratia angulata, Hook. f.
Ourisia macrophylla, Hook.
" *macrocarpa*, Hook. f.
Ligusticum haastii, F. von Müell.

Ligusticum aromaticum, Banks and Sol., var.
Gentiana bellidifolia, Hook. f.
Viola filicaulis, Hook. f.
Astelia nervosa, Banks and Sol.
Aciphylla colensoi, Hook. f.
Agrostis canina, L., var.
Raoulia parkii, Buch.
Angelica gingidium, Hook. f.
Viola cunninghamii, Hook. f.
Uncinia compacta, Br., var.
Cotula perpusilla, Hook. f.
Poa anceps, Forst., var.
Uncinia, sp.; tall, with narrow leaves.
Galium, sp.
Hydrocotyle novæ-zelandiæ, DC.
Coriaria angustissima, Hook. f.
Plantago brownii, Rafin.
Mimulus radicans, Hook. f.
Geum pusillum, Petrie (?).
Senecio bellidioides, Hook. f.
Schœnus pauciflorus, Hook. f.
Gnaphalium bellidioides, Hook. f.
Senecio lyallii, Hook. f.
Myosotis forsteri, Rœm. and Schultz.

Introduced Plants.

Stellaria media, Witt.
Holcus lanatus, L.
Trifolium repens, L.
" *pratense*, L.
Rumex acetosella, L.

Ferns.

Hypolepis millefolium, Hook.
Lomaria alpina, Sprengl.
Aspidium aculeatum, Sw., var.

To give some idea of the rapid reproduction of certain shrubs, in one square metre of ground were counted: *Veronica subalpina*, 118 plants, 0·34 m. to 0·02 m. in height; *Veronica canterburiensis*, 4 plants; *Veronica odora*, 1 plant; *Cassinia vauvilliersii*, 35 plants; *Coprosma* (with ciliated leaves), 2 plants: total, 160 plants.

The plants enumerated were all growing among the remains of the dead standing shrubs, and the list gives an example of how a vegetation of herbaceous plants and grasses will occupy the ground in the first instance, to be afterwards choked out by a new growth of shrubs. To summarise the results, the old scrub—consisting principally of *Gaya lyallii*, *Phyllocladus*

alpinus, and *Dracophyllum longifolium*—will be succeeded by an equally thickly-growing scrub, consisting principally of various *Veronicas* and *Cassinia vauvilliersii*, *i.e.*, in this particular portion examined the former leading shrubs will be completely absent, except *Gaya lyallii*, represented by one solitary specimen reproduced from an old plant, while a new scrub will take its place, consisting mainly of species very scantily represented in the old.

Section B: A very small section on the left-hand side of the West Coast Road, nearly opposite the living portion of Section A, beyond the Pass Creek. This was before the fire a thicket of *Veronica subalpina*. It is now reproducing itself much as it was before. Young plants of 0·26 m. in height abound, growing amongst the remains of the burnt vegetation. Close by, some dead stumps mark the former presence of *Phyllocladus alpinus*, which, as usual, has not reproduced itself. This section being extremely wind-swept, the bushes only attain to a height of about 1 m. at most, so do not become dense enough to hinder a growth of herbaceous plants, which thrive well under the shelter, and where burnt have been quickly reproduced, their growth perhaps stimulated by the excess of potash.

Section C comprises the portion of the pass between the burnt *Fagus* forest and the creek, special attention having been given to the portions near the forest. Here is only one living patch, a small piece of isolated *Fagus cliffortioides*, and, as that was not typical of the remainder, no notes were taken of its contents. Dead shrubs in abundance, and a few which escaped the fire, give good evidence of what the original scrub consisted, and which seems to have been almost the same as that described in Section A, with the exception that *Phyllocladus* formed quite three-quarters of the whole of that portion nearest to the bush. Nearer to the creek *Dracophyllum* was more common.

Section C.—Plants which have appeared in the Burnt Portion near the Bush since the Fire.

1. *Hypolepis millefolium*, Hook. f.; 0·30 m. in height. This forms the most striking feature of the new growth, and owes its origin most likely to the proximity of this scrub to the forest, whose shelter would be conducive to an original fairly vigorous growth of fern.
2. *Phormium cookianum*, Le Jolis; in quantity.
3. *Panax colensoi*, Hook. f.; reproduced after being burnt to the ground; 0·51 m. in height.
4. *Senecio elæagnifolius*, Hook. f.; 0·25 m. to 0·20 m. in height; seedling plants in abundance.

5. *Aristotelia fruticosa*, Hook. f.; seedlings plentiful in patches; height, from 0·50 m. to 0·45 m.

6. *Gaya lyallii*, Jack. and Hook.; reproduced from burnt stump; height, 0·35 m.

7. *Podocarpus nivalis*, Hook. f.; a few plants; 0·18 m. in height.

8. *Coprosma parviflora*, Hook. f.; plentiful in places; height, 0·48 m. to 0·40 m.

9. *Veronica canterburiensis*, J. B. Armst.; seedlings; 0·36 m. to 0·37 m. in height; occurs in quantity.

10. *Veronica subalpina*, sp. nov.; seedlings; plentiful in places; 0·30 m. in height.

11. *Cassinia vauvilliersii*, Hook. f.; seedlings; in medium quantity; 0·26 m. to 0·32 m. in height.

12. *Coprosma cuneata*, Hook. f.; reproduced from burnt stump; scarce.

13. *Veronica salicifolia*, Forst.; only one plant observed; 0 48 m. in height.

14. *Olearia illicifolia*, Hook. f.; in small quantity; seedlings; 0·14 m. in height.

15. *Coprosma serrulata*, Hook. f.; from an old plant; 0·50 m. in height.

16. *Coprosma ramulosa*, Petrie; in large patches; probably little damaged by fire, and may have formed considerable portion of original undergrowth.

17. *Myrsine nummularia*, Hook. f.; also in quantity, and perhaps little damaged in first instance.

18. *Phyllocladus alpinus*, Hook. f.; seedlings very rare and very small.

19. *Clematis australis*, Kirk; most likely from an old plant.

Of the new vegetation, *Veronica canterburiensis* will most likely, in time, form the greater part. It will be interesting to note the struggle for existence between the fern and the various seedlings. As the fern dies to the ground yearly, perhaps in the end it will succumb. I did not note many of the herbaceous plants in this portion of the section; they were not very abundant. Between this scrub and the creek, occupied formerly by a scrub, not very dense, and in other parts by a marsh and an alpine meadow, herbaceous plants are now a great feature, the whole tract being now occupied by a rich vegetation, conspicuous amongst which are huge patches of *Celmisia armstrongii*.

Section D comprises that portion of the pass adjacent to Lake Misery and the old moraine, as well as the flanks of Mount Rolleston, joining at its southern limit Section C. The portion near the lake forms a most instructive portion of

the Midland Railway fire. Formerly the lake was enclosed by subalpine scrub, and the south face of the moraine was also densely covered. The ground at the south end of the lake is rapidly becoming covered with fresh growth. In a patch of burnt *Dracophyllum longifolium* 20 cm. square were counted forty-five young plants of *Celmisia armstrongii*, and in 16 cm. by 8 cm. were thirty seedlings of *Ligusticum haastii*. The new scrub on this side will be, in large measure, *Veronica* and *Cassinia;* formerly *Dracophyllum longifolium* was the leading feature.

On the western side of the lake is a piece of subalpine scrub left intact. This is divided into two halves, where the fire partially burnt out its middle portion, and so forms a splendid example, for one can tell for a fact of what the original scrub exactly consisted. The following is a list of the present living species, arranged in order of most frequent occurrence:—

1. *Dracophyllum longifolium*, Br.; *Phyllocladus alpinus*, Hook. f.
2. *Coprosma parviflora*, Hook. f.; *Olearia nummularifolia*, Hook. f.; *Cassinia vauvilliersii*, Hook. f.
3. *Gaya lyallii*, Jack. and Hook.; *Dacrydium colensoi*, Hook. f.; *Panax colensoi*, Hook. f.
4. *Dracophyllum traversii*, Hook. f.; very plentiful in the tallest, but not common in the lowest scrub.
5. *Hymenanthera*,* sp.; scarce.
6. *Veronica odora*, Hook. f.; very scarce.
7. *Clematis australis*, T. Kirk; scarce.
8. *Veronica subalpina*, sp. nov.; very scarce.

Especially noticeable is the small quantity of *Veronica*.

Herbaceous Plants and Grasses.

Phormium cookianum, Le Jolis; a few plants.
Viola cunninghamii, Hook. f.
Ourisia macrophylla, Hook. f.
Danthonia raoulii, Steud.
And perhaps others not noted.

List of Plants which have appeared in Burnt Portion of Section D since the Fire.

Coprosma serrulata, Hook. f.; in quantity.
Senecio elæagnifolius, Hook. f.; in quantity.
Cassinia vauvilliersii, Hook. f.; in quantity.

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* One of the species doubtless formerly included under *H. crassifolia*, Hook. f.; but, in absence of specimens, I am not able to refer it to its new species according to Kirk in "Transactions of the New Zealand Institute," vol. xxviii., p. 510: "A Revision of the New Zealand Species of *Hymenanthera*, R. Br.," by T. Kirk, F.L.S.

Dracophyllum longifolium, Hook. f.; in quantity.
Veronica canterburiensis, J. B. Armst.; in large quantity.
„ *odora*, Hook. f.
Olearia nummularifolia, Hook. f.
Coprosma cuneata, Hook. f.; from burnt stump.
Aristotelia fruticosa, Hook. f.
Gaya lyallii, Jack. and Hook.
Phyllocladus alpinus, Hook. f.; one plant unburnt.
Coprosma; ciliated variety.
Podocarpus nivalis, Hook. f.
Olearia illicifolia, Hook. f.; from old stump.
Veronica salicifolia, Forst.
Gaultheria rupestris, Br.

Portions of this patch contain very few seedlings, the ground being occupied by *Coprosma serrulata*, *Lomaria procera*, and *Phormium*. Regarding *C. serrulata*, see remarks in Section E.

Although the plants are not coming up so closely as in many places, there is no reason to doubt but that in time they will form a dense mass, unless the growth of *Phormium* should prove too much. Part of the new scrub at the base of the moraine is already one dense mass of *Veronica subalpina* and *Cassinia*, averaging 0·52 m. in height.

At the margin of the lake, on the north side, is a flat patch of peaty ground covered with unburnt dwarf scrub, consisting of *Veronica odora*, 0·90 m. in height; *Dacrydium laxifolium*, Hook. f.; and *Dacrydium bidwillii*, Hook. f.; together with a few plants of *Coprosma propinqua*, A. Cunn. A continuation of this was burnt, and *Veronica odora* has since appeared in large quantities. Behind this is also another example of *Veronica* reproducing itself to the exclusion of all other shrubs. Proceeding up the face of the moraine towards its summit the following were noted as having appeared since the fire:—

Veronica subalpina, sp. nov. (ined.); in large and close-growing patches, 0·60 m. in height.

Olearia illicifolia, Hook. f.; at times.

Senecio elæagnifolius, Hook. f.; plants here and there.

Coprosma serrulata, Hook. f.

Phyllocladus alpinus, Hook. f.; one or two seedlings noted, and these were among the very few seen during the taking of these notes.

Olearia colensoi, Hook. f.; the only plant of this species noted in this locality.

Panax colensoi, Hook. f.; *Dracophyllum longifolium*, Hook. f.; *Phyllocladus alpinus*, Hook. f.; *Coprosma cuneata*, Hook. f.: a few plants spared by the fire.

In many places the reproduction is not very extensive. Here and there great numbers of seedlings of *Dracophyllum longifolium* were met with. In one spot, 0·18 m. by 0·20 m., fourteen seedlings were counted. This species will probably occupy the upper portion of the moraine in time to come.

Where the fire has passed over the adjacent slopes of Mount Rolleston (Canterbury), as far as the eye can reach is green with *Veronica.* On the wind-swept summit of the moraine the former subalpine scrub has been nearly eradicated, the only shrubby vegetation reappearing being *Coprosma serrulata,* together with herbaceous plants in the shape of large quantities of *Celmisia armstrongii, Phormium,* and *Aciphylla colensoi.* The moment, however, any shelter comes —for instance, a large rock or a slight depression in the ground—*Dracophyllum longifolium* in quantity, *Senecio elæagnifolius, Veronica canterburiensis,* and *Olearia illicifolia* make their appearance. With this section I include the slopes of Mount Rolleston, over which the fire swept in all its fierceness. These were formerly covered with a dense scrub similar to that described in this section, but wanting *Dracophyllum traversii.* I well remember before the fire forcing my way through it. It is now the home of vast numbers of herbaceous plants, from seedlings to those of full maturity. Especially conspicuous is *Ligusticum haastii, Celmisia coriacea, Celmisia armstrongii, Ourisia macrocarpa,* and *Phormium cookianum;* indeed, here may be found representatives of nearly all the herbaceous flora of the district, except those plants which seem to require for their well-being a deep winter covering of snow, or those whose habitats are rocks at a high altitude. Amongst these plants shrubs are rapidly springing up, as pointed out in Section A, especially *Coprosma serrulata, Coprosma ramulosa* (in places), *Cassinia vauvilliersii,* and *Dracophyllum longifolium.* Where the scrub was formerly very thick *Veronica subalpina,* 0·45 m. to 0·60 m. in height, occurs in large quantity, together with *Coprosma parviflora* (common), *Gaya lyallii, Clematis australis* (common), *Aristotelia fruticosa* (not so abundant), *Coprosma acerosa* (a little), and *Gaultheria antipoda.*

Section E: This is of considerable size, and occupies all the right bank—south—of the River Otira from the West Coast Road for a distance of 1 kilom. up the river to an altitude of 1,000 m., from which point the ancient scrub is untouched, so far as its extreme altitudinal limit. This section was examined with considerable care, so far as time would permit, and is described at some length, in view of future observations, although a good deal is merely repetition of what has gone before.

Proceeding along the slope above the river in many places at first the original scrub was not very dense, and consisted in large part of *Dracophyllum longifolium*, and such shrubs as have been previously shown to be associated with it. These are not in general reproducing themselves. *Coprosma serrulata* has often taken complete possession; and of this species, strange to say, no young plants were observed. This creeping shrub must have great power of resisting fire, its strong underground stems apparently escaping injury. So soon as the fire is over it must recommence growth at a great rate, there being no longer the dense shade to keep it in check; and so, for a time, the sole survivor, it takes possession of the place, spreading entirely by means of its underground stems, their growth possibly stimulated by the potash as well as by the extra light, air, and direct rain. These remarks apply, though in a limited degree, to its more recently described relative *C. ramulosa*. These will probably in time to come remain almost the sole occupants of the large areas they have seized upon.

Proceeding up the river, here and there young plants of *Dracophyllum longifolium* were met with; also a sprinkling through the whole of *Olearia illicifolia*. Perhaps the great feature of this portion of the section is the vast number of seedling plants of *Celmisia*, especially *C. armstrongii*, which must have increased considerably in quantity since the fire. Less than two years after the fire I was over this same ground, and *Celmisia* was then germinating in great abundance. A few plants of *Senecio elæagnifolius* and *Gaultheria antipoda* were also noted.

Proceeding up the river-bank a gully is reached where formerly existed a much taller and denser scrub. This—the species being arranged in their order of frequency—consisted of—*Gaya lyallii*, *Phyllocladus alpinus*, *Senecio elæagnifolius*, *Dracophyllum longifolium*, *Olearia nummularifolia*, all these in plenty; with, in smaller quantity, *Coprosma cuneata*, *Veronica salicifolia*, *Podocarpus nivalis*, and *Senecio bidwillii*. Here *Veronica subalpina*, 0·20 m. to 0·80 m. in height, is in great quantity, and, with *Phormium* and *Coprosma serrulata*, will replace the original totally different scrub.

Other seedlings observed here, but in much smaller quantity, were: *Veronica canterburiensis*, *Coprosma parviflora*, *Coprosma acerosa*, *Olearia illicifolia*, *Veronica salicifolia* (here and there), *Coprosma cuneata*, *Coprosma ramulosa*, *Coprosma retusa*, Petrie, with here and there a few of such trees as usually are amongst those which escape burning. It is worthy of remark that no *Veronica subalpina* was observed in the still standing scrub.

Passing over this gully, at first *Coprosma serrulata* takes precedence, and then a considerable quantity of *Dracophyllum*

longifolium and *Veronica subalpina* is met with, which must in time form a thick scrub. Wherever the ground gets moister *Veronica odora* makes its appearance in considerable quantity, 0·45 m. to 0·52 m. in height, and already blooming. Further on still are remains of dense *Dracophyllum*, now replaced by the three *Veronicas*, 0·55 m. to 0·58 m. in height. One patch of *Veronica subalpina*, in area 5 m. by 1·60 m., measured in height 0·70 m. At about 1 kilom. from the road the burning ceased, a creek from Mount Rolleston proving a barrier to the fire. Across this creek the original subalpine scrub is encountered in its primeval state. Here it is so dense as to be practically impassable. Just before reaching this point the reproduction is not very fast, the young scrub consisting mainly of *Veronica subalpina* and *Coprosma serrulata*, together with *Phormium* in plenty, herbaceous plants, and grasses. Over the whole of this section *Epilobiums* have been frequent, three species being mainly observed. *Epilobium*, as a rule, is very abundant after fire, the burnt forest near Lake Wakatipu, on the Humboldt Mountains, abounding in varieties, many of which are possibly hybrids.

List of Shrubby Plants in the Primeval Subalpine Scrub of Section E.

(1.) *Growing on Stony Ground and with Partial Shelter.*

Veronica subalpina, sp. nov. (ined.).
Coprosma cuneata, Hook. f.
Senecio elæagnifolius, Hook. f.
Coprosma, ciliated sp.
Senecio bidwillii, Hook. f.
Dracophyllum longifolium, Br.; not in quantity.
Muhlenbeckia axillaris, Hook. f.
Veronica canterburiensis, J. B. Armst.
Olearia nummularifolia, Hook. f.
Hymenanthera (*vide* note, *ante*).

Species where the Scrub becomes taller.

Panax colensoi, Hook. f.; in quantity.
Senecio elæagnifolius, Hook. f.; in quantity.
Phyllocladus alpinus, Hook. f.; in quantity.
Archeria traversii, Hook. f.

And those enumerated above in smaller quantity, and *Veronica* almost altogether absent.

To sum up, there is on the ridges a tall *Dracophyllum-Phyllocladus-Panax* scrub, and in the hollows a dwarfer one of *Veronica* and various dwarf shrubs of which *Olearia nummularifolia* fills a large part. Very little *Coprosma serrulata* was seen, *Podocarpus nivalis*, and in places *Coprosma ramulosa*, being in its stead.

On the opposite—north—side of the River Otira the fire spread to the grass-meadow-line. Here is only one small patch of scrub to indicate the former vegetation, and this is of the usual mixed description common to high levels in Westland, and described in Section D. *Veronica subalpina* and *Cassinia vauvilliersii* are rapidly occupying the burnt ground, especially the former species. Of this portion I can give no detailed account, not having had opportunity to examine it carefully.

Section F includes the slopes of Mount Rolleston (Westland), on the left bank of the River Otira, near the junction with Peg-leg Creek, and stretches south and west to Section E. It was here that the fire originated. Only the living scrub was examined carefully, the state of the River Otira not allowing the slopes on Mount Rolleston to be examined. There the chief plant seemed to be *Dracophyllum longifolium.* My notes say, "The scrub is being reproduced, but not, so far as I could see, to any great extent." The constituents of the former scrub are identical with the list in the next section.

Section G comprises Peg-leg Flat and all the adjacent slopes of Hill's Peak, as far as the slope opposite to Lake Misery. This was burnt by the first fire, the date of which I am unable to furnish; nor do I know whether the whole of this section was burnt at the same time. The evidence of the standing stumps and the state of the reproduced plants seems to point to more than one fire. It is also possible that in more than one place the Midland Railway fire may have reburnt some of this, or some may have been fired separately at or after that time. Be this as it may, an excellent example is shown of what takes place on the burnt ground after a considerable number of years have elapsed.

Commencing at Peg-leg Flat is the living remains of a scrub burnt perhaps twenty years ago. This is more correctly designated low forest than subalpine scrub, and contains, as did all the original scrub of this section and Section F, in addition to most of the plants already treated of, various members of the forest at a lower level, and which here exist at their highest altitudinal limit.

List of Shrubs forming Low Forest, near Peg-leg Creek (in order of abundance).

Dracophyllum traversii, Hook. f.; in large quantity.
Gaya lyallii, Jack. and Hook.; in large quantity.
Olearia illicifolia, Hook. f.; nearly as abundant.
Panax colensoi, Hook. f.; plentiful.
Dacrydium colensoi, Hook. f.; plentiful.

Phyllocladus alpinus, Hook. f.; plentiful.
Senecio elæagnifolius, Hook. f.
Griselinia littoralis, Raoul.
Coprosma parviflora, Hook. f.
Panax anomalum, Hook. f.
Podocarpus nivalis, Hook. f.
Coprosma cuneata, Hook. f.
Dracophyllum longifolium, Br.
Myrsine pendula, Col. (?).

Underneath this are large quantities of seedling plants, of which the chief are:—

Gaya lyallii, Jack. and Hook. f.; in great variety.
Senecio elæagnifolius, Hook. f.
Veronica salicifolia, Hook. f.
Aristotelia fruticosa, Hook. f.
Coprosma parviflora, Hook. f.
Griselinia littoralis, Raoul.
Panax colensoi, Hook. f.

The portion of the hillside adjoining this is now one mass of young growth. Seedlings of all kinds are present, also growth from burnt stumps. The following is a fairly complete list:—

Senecio elæagnifolius, Hook. f.; very abundant.
Coprosma parviflora, Hook. f.; abundant.
" *acerosa*, A. Cunn.; abundant.
Dracophyllum longifolium, Br.; abundant.
Cassinia vauvilliersii, Hook. f.; abundant.
Veronica canterburiensis, J. B. Armst.; small seedlings.
Coprosma serrulata, Hook. f.
Gaultheria rupestris, Br.
Veronica subalpina, sp. nov.; not abundant.
Olearia nummularifolia, Hook. f.; not abundant.
Gaultheria antipoda, Forst.; not abundant.
Dacrydium laxifolium, Hook. f.
" *colensoi*, Hook. f.; only one plant noted.
Podocarpus nivalis, Hook. f.
Panax colensoi, Hook. f.

The height of this new scrub is from 2 m. to 0·60 m. In one place on the terrace facing south-west *Dracophyllum longifolium* is the leading variety, it having taken the place of a former dense growth of *Dacrydium colensoi*.

As Peg-leg Creek is approached the burning was only partial, and here, notwithstanding, a new growth similar to that just enumerated has made its appearance.

At a higher altitude *Dracophyllum longifolium* and *Senecio elæagnifolius* appear to be the leading shrubs.

Descending the terrace, and crossing Peg-leg Creek, on

the very steep slope which forms the commencement of its gorge is both living and burnt vegetation. The living consists of low forest 6 m. in height (Plate XXXVII.), of the following species :—

Panax simplex, Forst.
Griselinia littoralis, Raoul.
Phyllocladus alpinus, Hook. f.
Olearia illicifolia, Hook. f.
Archeria traversii, Hook. f.
Dacrydium colensoi, Hook. f.
Gaya lyallii, Hook. and Jack.
Panax colensoi, Hook. f.
Olearia macrodonta, Hook. f.
Dracophyllum traversii, Hook. f.

The abundance or otherwise of this was not noted. Underneath the shade of these shrubs are seedlings of most of the above, together with *Panax anomalum*, *Panax lineare*, and *Rubus schmidelioides*, A. Cunn.

Where the scrub was burnt on the steep face few seedling plants have appeared, the whole surface being invaded by a strong growth of *Lomaria procera* and *Phormium cookianum*. The following were noted :—

(1.) *Growing from Old Stumps.*

Coprosma serrulata, Hook.
Olearia nitida, Hook. f.
Gaultheria rupestris, Br.

(2.) *Seedlings.*

Coprosma cuneata, Hook. f.
Olearia haastii, Hook. f.
" *illicifolia*, Hook. f.
Veronica subalpina, sp. nov.
Olearia avicenniæfolia, Hook. f.

This face catches the full force of the north-west wind, and so in all probability the covering of fern and *Phormium* will hold its own.

Between the unburned scrub and the West Coast Road, in an almost identical situation, reproduction is going on freely, *Veronica salicifolia* and *Olearia illicifolia* forming the main portion, and in such quantity as to be likely to exterminate the fern. Proceeding up the road until opposite to Lake Misery, and facing between west and south-west, is a portion of Hill's Peak, the scrub on which formerly consisted in the main of :—

Dracophyllum traversii, Hook. f.
" *longifolium*, Br.
Phyllocladus alpinus, Hook. f.
Gaya lyallii, Jack. and Hook. f.

Olearia nummularifolia, Hook. f.
Coprosma cuneata, Hook. f.

This is now being reproduced in the form of—

Veronica subalpina, sp. nov., about 50 per cent.
Olearia ilicifolia, Hook. f.
Senecio elæagnifolius, Hook. f.

And a few plants here and there of—

Panax colensoi, Hook. f.
Cassinia vauvilliersii, Hook. f.
Gaya lyallii, Jack. and Hook. f.

On the slopes of the neighbouring mountains it is quite easy to tell of what the primeval scrub chiefly consists by the colour of the vegetation, a reddish-brown pointing out the presence of *Dracophyllum*, and a greyish-green that in which *Phyllocladus* is the leading tree.

These various sections described give a fair idea of what the vegetation once was over the greater part of Arthur's Pass and its vicinity, and of what is now coming into its place, where destroyed by fire. Some of the sections I was, of course, able to examine with greater care than others, while a very wet season and other botanical work hindered my reporting on certain very interesting portions of the area. I ascended the mountains on both sides of the pass more than once to a considerable altitude, but, beyond noting that the fire reached to 300 m. above the pass in places, took no notes; such at the extreme limits of the fire should be of great interest. To some extent those taken at 1,000 m. up the Otira Valley supply this want. Looking over these notes, the following conclusions seem to be fairly justified:—

1. That subalpine scrub such as that in the Arthur's Pass district, after fire, is usually re-established, but in a different form to that which it had before the fire.

2. That the nature and amount of its re-establishment depends in large measure on the situation of the original scrub with regard to altitude, sunshine, and prevailing winds.

3. That *Veronicas* of various species often entirely take possession of places where formerly not a single *Veronica* existed.

4. That a *Veronica* scrub reproduces its like.

5. That *Dracophyllum longifolium*, Br.; *Senecio elæagnifolius*, Hook. f.; and *Cassinia vauvilliersii*, Hook. f., are also very readily reproduced after fire, and will form a large part of the future vegetation.

6. That fire in such a region as Arthur's Pass does little or no damage to herbaceous plants, grasses, and ferns; that, on the contrary, certain species, such as *Celmisia armstrongii*, Petrie, and perhaps *Phormium*, become more abundant.

7. That certain low-growing, creeping shrubs, notably *Coprosma serrulata*, Hook. f., and to a lesser extent *C. ramulosa*, Petrie, multiply by stolons to an astonishing extent, and become quite a new feature in the vegetation.

8. That certain shrubs specified in the foregoing notes, when burnt to the ground, readily spring up again from the old stock.

9. That the seedlings most frequent under the growing scrub are not the same species as those which appear in the open most abundantly after a fire.

10. That *Dracophyllum traversii*,* Hook. f., is completely eradicated by fire; also that *Dacrydium colensoi*, Hook. f., and *Phyllocladus alpinus*, Hook. f., are almost eradicated.

11. That, owing to certain shrubs no longer playing a leading part in the vegetation, the colours of a mountain-side would be changed after reproduction of the vegetation.

Why certain shrubs should not be reproduced, and others reproduce themselves so readily, or even usurp ground not originally their own, brings me from the region of fact to that of conjecture. *Veronica*, the most striking example of this, has always seemed to me a genus in which the species are not yet completely differentiated.† The late J. Ball, F.R.S., held similar views with regard to *Escallonia*, *Rubus*, *Hieracium*, *Solidago*, and other genera. Writing of *Escallonia*, he says, "It is easy to find specimens not exactly agreeing with any of the described species, and to light upon intermediate forms that seem to connect what appeared to be quite distinct species. They afford an example of a fact which I believe must be distinctly recognised by writers on systematic botany—that in the various regions of the earth there are some groups of vegetable forms in which the processes by which species are segregated are yet incomplete, and amid the throng of closely allied forms the suppression of those least adapted to the conditions of life has not advanced far enough to differentiate those which can be defined and marked by a specific name. To the believer in evolution it must be evident that at some period in the history of each generic group there must have occurred an interval during which species as we know them did not exist."‡

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* Of this no seedlings were noted, but on the more western mountains seedlings are not uncommon, in association with mature plants.

† The species of *Veronica* as described by various botanists vary so much that no good key to the New Zealand species has as yet been published. In one gully on Mount Torlesse I have collected thirty quite distinct forms of *Veronica odora*, many of which are so distinct in appearance that a systematic botanist unacquainted with this variability would at once assign to them specific rank; and so with most of the other species as now known.

‡ "Notes of a Naturalist in South America," by John Ball, F.R.S. (p. 181).

If this be so, then a genus in such a phase seems to me to be at its greatest height of vigour, as evidenced in this case by *Veronica* taking entire possession of an alien's territory and easily repopulating its own. And the converse of this should hold true—that a very well defined species, confined to a certain restricted environment, will be verv ancient and of feeble reproductive powers; such an one is *Dracophyllum traversii*, found only at a certain altitude, with plenty of shelter provided by neighbouring shrubs, and only in positions of excessive moisture and great drainage. It would possess little vital energy, and so be ill able to reproduce itself under changed conditions. And so with all other species; so that by a series of investigations in various parts of our Island it might be shown which are modern and which more ancient forms, the comparative age of any species being so determined by observations made not merely after fire, but on prevalence of seedlings, vitality of seed, ease of culture, and the like.

A fire thus may give us some idea of what may happen to the vegetation as the climate slowly changes, those forms which are comparatively young being the survivors, while the old will perish. Thus, from the tabulated results of such burning as this described here, we may get some idea of the future vegetation, shrubby *Scrophularineæ*, *Compositæ*, and *Rubiaceæ* in large measure taking the place of pines* and *Epacrideæ*.† Some bearing, too, my subject may have on the history of man in this Island. Fires having had their origin in early Maori times would still, perhaps, leave their mark in the shape of subalpine scrub of new form, and the age of such would indicate the presence of man in that region at that date.

Apart from the scientific significance of this subject, it is of interest from the layman's point of view, showing as it does that a large portion—the most beautiful portion, in fact—of our flora is not in great danger of eradication by fire; that if areas were set apart as national parks in the alpine and subalpine regions, and cattle and sheep kept religiously away, although an accidental fire might sweep over the whole locality, the loss to the colony and to science in the destruction of our unique subalpine flora need not be feared (see Plate XXXVI.).

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* Dr. Diels says, "Ferns, *Coniferæ*, *Restiaceæ* (probably), and certain *Epacrideæ* belong to the most primitive elements of the New Zealand flora (*l.c.*, p. 292). (Translated.)

† *Dracophyllum longifolium* may seem an exception, since it has been reproduced in large quantities; but, as may be seen on reference to the various sections, its place is constantly being taken by other plants.

DESCRIPTION OF PLATES XXXV.-XXXVII.

PLATE XXXV.

Portion of unburnt subalpine scrub, with *Aciphylla colensoi* in centre, *Veronica canterburiensis* on left-hand side, and *Phormium cookii* on right hand. Part of Section A.

PLATE XXXVI.

Herbaceous plants in Section C, reproduced after fire. *Astelia nervosa, Ligusticum haastii*, and *Ourisia macrocarpa* at bottom of plate; higher up *Celmisia coriacea* for most part.

PLATE XXXVII.

Portion of Section G in foreground, and part of Section E with Canterbury spur of Mount Rolleston in distance. Burnt and living subalpine scrub. Towards the centre of the plate *Phormium* and fern may be seen taking possession.

ART. XXXIV.—*Descriptions of New Species of* Astelia, Veronica, *and* Celmisia.

By L. COCKAYNE.

[*Read before the Philosophical Institute of Canterbury, 22nd February, 1899.*]

Astelia petriei, sp. nov.

A densely tufted evergreen plant, with large, thick, coriaceous, long-pointed leaves arising from a tuberous stem, and spreading into large patches by means of wiry subterranean stolons.

Leaves from 55 cm. long × 3 cm. broad in large specimens to a few centimetres long in small ones, linear-subulate, with a long acicular apex; upper surface almost glabrous, except for some scattered minute scaly hairs and a very few distant longer pale hairs, furrowed with many unequal longitudinal furrows, the two halves bent upwards at an angle with the sunken purple midrib, so forming a deep channel, especially towards base of leaf; under-surface with sharp green midrib, silvery with thin scaly tomentum, except on the numerous parallel green nerves; margins entire, with a few scattered hairs; sheaths pale-coloured or white, very fleshy towards the base, completely surrounding the leaf-sheath beneath, and joined to sheath on opposite side by a thin delicate transparent membrane continuous with the epidermis, the whole bundle of leaf-sheaths forming a false stem, which arises from the tuberous stem below; margins and dorsal surface of sheath hairy, with pale straggling hairs.

Inflorescence (male): A short, stout, upright panicle sunken among the foliage leaves, with branches 3·5 cm. long, or less, arising from axils of long leafy bracts, which resemble in all respects the foliage leaves, except for longer less-adpressed hairs; upper bracts much shorter than lower.

Flowers crowded, very shortly pedicelled, strongly scented, semi-erect; perianth segments linear or ligulate, purplish and yellow at base; filaments stout; anthers black; stigmas 3, capitate; ovary (when present) 3-furrowed to about middle.

Inflorescence (female) shorter than male.

Flower: Perianth segments ovate, acute, sometimes trifid, pilose at apex.

Hab. South Island: Mount Rolleston, Canterbury; *L. C.*: Walker's Pass, Canterbury and Westland; *R. Brown* and *L. C.* (1889): Kelly's Hill, Westland; *D. Petrie* and *L. C.*: Humboldt Mountains, Otago; *L. C.*

This plant may be at once distinguished from *A. nervosa*, Banks and Sol., var. *alpina*, T. Kirk, by its shining pale-coloured very stiff leaves, which are much less hairy on the upper surface. It grows in hollows on alpine meadows where the snow remains often until end of December or beginning of January, and which will be very wet during early summer and dry in the autumn, at an altitude of from 1,300 m. to 1,500 m. It is very easy to cultivate, but, although I have had plants for nine years, they have never bloomed, nor did I ever observe bloom on the wild plants until January, 1898. The above description is drawn up from very imperfect material, and will certainly require considerable modification. The strong and perhaps disagreeable odour of the flowers, together with the dark-purple colour, suggests fertilisation by blowflies.

Veronica subalpina, sp. nov.

An evergreen shrub with small leaves, 75 m. to 2 m. in height.

Branches not very dense, sometimes spreading, marked above with old leaf-scars; bark green, often tinged, stained, and spotted with purple; youngest twigs green, minutely pubescent.

Leaves usually patent, not very coriaceous, bright pale-green, shining above, duller beneath, sessile, narrow-lanceolate or broader at times, 3 cm. to 3·5 cm. long, subacute; upper surface concave, sometimes arched with apex pointing downwards; midrib sunken above, raised slightly beneath.

Racemes usually in a pair at the ends of the branches from axils of terminal leaves, short, equalling or rather longer than the leaves, with rhachis equalling peduncle.

Flowers crowded; pedicels minutely pubescent, equalling the calyx; bracts short, variable in shape, oblong or deltoid,

acute, truncate or lacerate, ciliated, with slightly membranous margins; sepals acute, ovate, equalling the corolla—tube, ciliated with short hairs; corolla-tube with short hairs round the throat, near junction of segments: segments half as long again as the tube, ovate-oblong, obtuse.

Capsule ovate, acute, often with short apiculus, twice or hardly twice as long as the calyx.

Hab. Mountains of Westland, and those of Canterbury within region of western rainfall, at altitude of from 750 m. to 1,200 m.

This species, hitherto referred sometimes to *V. traversii*, Hook. f., and sometimes to *V. lævis*, Benth., is, when seen growing, a most easily recognised plant. It is the common, and away from the actual divide the only (*V. salicifolia* excepted), alpine *Veronica* of Westland. It does not vary to any great extent, thus differing most materially from its relatives of the drier regions. In cultivation it remains unchanged.

Veronica barkerii, sp. nov.

A stout erect upright-branching shrub.

Branches terete, brownish-purple, with upper internodes 1 cm. long.

Leaves 5 cm. × 1·2 cm., lanceolate or oblong-lanceolate, acute or subacute, sessile, narrowed towards base, entire, pale apple-green, duller on under-surface, fleshy, patent; midrib sunken on upper very slightly raised on under surface.

Racemes about as long as the leaves, usually 2-paired at ends of branches, densely flowered, rounded at apex, cylindric; peduncles, pedicels, bracts, and calyx pubescent; peduncle green, stained with purple below, bright-purple towards apex; bracts half as long as the pedicels, subulate, acute, concavo-convex, embracing the pedicel; calyx-lobes cut nearly to base of calyx, 3 mm. to 3·5 mm. long, nearly as long as corolla-tube, ovate-lanceolate, acute, conspicuously stained on membranous margin with pink-purple: corolla—tube, 3 mm. long, throat hairy; limb, spreading, 7 mm. × 7 mm.: segments 3 mm. long, upper and lateral equal, lower smaller, broadly ovate, obtuse, margins and apex incurved, white, stained deeply on margin with lilac-purple; anthers much exserted, very wide-spreading; style most pubescent, pink; stigma bright-purple.

Capsule 5·5 mm. × 4 mm., flattened, ovate, acute or subacute with mucro, not quite twice length of calyx.

Hab. Chatham Islands; *S. D. Barker* (1898).

This beautiful shrub, collected by Mr. S. D. Barker, after whom I have much pleasure in naming it, is closely related to *V. dieffenbachii*, but differs in its erect not spreading habit, smaller leaves. shorter racemes, its extremely pubescent style,

and its midrib not conspicuously raised. I think, when the plants of the Chatham Islands are carefully studied from living specimens, that many forms now considered identical with those of New Zealand proper will be found distinct.

Veronica glaucophylla, sp. nov.

A low-growing round shrub, with very close-set branches, glaucous leaves, and pubescent inflorescence.

Stem terete, brownish, pubescent, especially on young wood, with internodes half length of leaf.

Leaves small, 1·6 cm. × 6 mm., linear-ovate or linear-oblong, slightly concave on upper surface, glaucous on both surfaces, entire, very obscurely ciliated, patent, with laminæ horizontal, almost sessile, with broad short concavo-convex petiole; midrib sunken above and beneath.

Racemes 5·7 cm. long, much exceeding termination of branches, tapering towards tip, with close-set flowers; pedicels equalling or smaller than calyx; bracts one-third length of pedicel, subulate, ciliated, acute; calyx ovate, acute or subacute, ciliate, scarious, rather longer than corolla-tube: corolla—tube, 1·5 mm. long, white, hairy in throat, widening towards limb; limb, spreading: segments 2 mm. to 3 mm. long, oblong, concave above, white, rounded at apex, upper and two lateral equal, lower much smaller; ovary pubescent; style long, straight, much exserted, pubescent; stamens much exserted, spreading.

Capsules 5 mm. × 4 mm., broadly ovate, subacute, pubescent, flattened, rather more than twice as long as calyx.

Hab. Craigieburn Mountains, Canterbury, at altitude of 1,200 m. (1890); *L. C.*

Easily recognised by the round habit of growth, very glaucous small linear-ovate acute leaves, slender racemes of short white flowers with long exserted style, pubescent ovary, and very small bracts.

Celmisia flaccida, sp. nov.

Leaves narrow-lanceolate to lanceolate, from 21 cm. to 14 cm. long × 27 mm. to 20 mm. broad, spreading, soft, coriaceous only when dry, with subserrate considerably recurved margins; lamina at base usually tapering into the petiole, occasionally slightly rounded; upper surface covered with thin pellicle of white sometimes brownish silky tomentum, wrinkled into long parallel ridges, leaving broader furrows between, pale-green, yellowish-brown when dry; under-surface densely covered with a thick mat of white or yellowish-white silky tomentum; midribs stout, widening gradually towards petiole; nerves usually six pairs; petioles rather more than half as long as lamina, contracted and very

fleshy at junction with lamina, gradually widening out into a broad white transparent sheathing base, covered with loose cobwebby hairs, numerous on under-surface, and especially on margin of sheath, fewer on upper surface and constricted portion. Scapes half as long again as the leaves, somewhat flattened, with sharp edges and slightly twisted, quite flat in herbarium specimens, tomentose with hairs as on leaf-sheaths, bracteate; bracts numerous, amplexicaul, fleshy, leafy, subulate or linear, 5 cm. to 6 cm. in length, few towards base but very numerous and imbricating towards summit of scape where the uppermost surround the flower-head, green above, purple beneath, especially on prominent rounded or sharp midrib, with margins of sheath very cobwebby; involucral scales numerous, densely imbricating, about as long as the disc-florets, linear, cobwebby, brown, inner series greener. Head 4·5 cm. in diameter; disc-florets densely crowded, numerous, divisions of corolla thickened round margin; rays linear-spathulate, 17 mm. long × 2 mm. broad, marked with parallel ridges and furrows, faintly serrate, tip yellowish-green, often swollen or bifid; pappus 6 mm. to 7 mm. long. Achenes ripe, not seen, almost glabrous.

Hab. Wet ground, near margins of swamps, in company with *C. petiolata*, Arthur's Pass; altitude, 900 m.; *L. C.* (1898). Blooms in early January or late in December.

This species has very possibly hitherto been confused with *C. monroi*, Hook. f., an imperfectly understood species, and possibly a mixture of *C. armstrongii*, *C. linearis*, *C. coriacea* (with narrow leaves), *C. longifolia*, and the above. At once distinguished from *C. coriacea* by its narrower and comparatively flaccid leaves and its much smaller flower. It seems most nearly related to *C. brownii*, of the Southern Lakes district, but is altogether a smaller plant, and very distinct in appearance. From *C. spectabilis* its tomentum at once separates it.

Celmisia mollis, sp. nov.

Leaves lanceolate, tapering into petiole or rarely subcordate at base, from 11 cm. to 23 cm. long × 2·5 cm. to 2 cm. broad, not coriaceous; lamina, upper surface shining, wrinkled into unequal longitudinal furrows, sparsely hairy with scattered weak white hairs; under-surface covered with flannelly pale-yellow tomentum, densely matted below but free and shaggy towards tips of hairs, very soft to the touch, especially when dry; margins entire, slightly recurved, covered with brown-coloured tomentum; nerves evident, about six pairs; midrib raised, for short distance broad, purple, more hairy than the green surface, into which it gradually merges; petiole

fleshy, as long as the lamina, constricted at junction with blade, but gradually widening into a broad sheath, purple, covered but not densely, except towards margin of sheath, with cobwebby yellowish-white, almost white, hairs. Scape often twice as long as the leaves, purple, densely covered with long brown hairs; bracts not very numerous, usually 6 to 8, linear, purple, sheathing with lower half, hairy as scape; involucral scales numerous, covered with shaggy yellowish hairs above, except towards and on the membranous brown tip, glabrous beneath. Heads about 2·7 cm. in diameter; ray-florets 12 mm. × 2 mm., 4- to 6-nerved, nerves swollen at bifid or trifid apex; corolla-tube of disc-florets hairy, especially at base, marked with purple lines from junction of segments to base. Achenes not seen.

Hab. Hill's Peak, Canterbury, at altitude of 1,200 m.; *L. C.* (1898). Flowers in early January.

Seems closely allied to *C. cordatifolia*, Buchanan, but differs in tomentum—one of the most constant characters in *Celmisia*—and the usually tapering leaf-bases. Distinguished from *C. petiolata* by its shaggy, not altogether adpressed tomentum, which is yellow not white, and its wrinkled upper leaf-surface. It is very probably a hybrid between *C. petiolata* and *C. spectabilis.* I have a very closely related form from Jack's Pass, Hanmer, which may be a local variety of the above or a hybrid between *C. traversii* and *C. spectabilis.* This hybrid theory seems the more likely, since I have a most magnificent *Celmisia* from the last-named locality which in appearance is midway between *C. traversii* and *C. coriacea.*

Art. XXXV.—*On* Ligusticum trifoliatum, *Hook. f.*

By L. Cockayne.

[*Read before the Philosophical Institute of Canterbury, 22nd February, 1899.*]

Regarding *L. trifoliatum,* Sir J. D. Hooker wrote: "A curious little species, at once known by the few petioled leaflets; it is probably 2-pinnate or 2-ternately pinnate. I have only two specimens, and in the absence of fruit am not certain of its genus" ("Handbook of the New Zealand Flora," p. 97). The late Mr. T. Kirk, F.L.S., urged me repeatedly to search for this plant, saying that it had never been found since its original discovery by Haast. I made repeated search in the habitats mentioned by Haast—"watercourses by the

Kowai River, altitude 2,000 ft.–3,000 ft."—but was always unsuccessful, and it was not until last April that, while in company with Professor A. Dendy, I stumbled across the plant by the merest accident, growing not by the side of streams, but in *Sphagnum* swamps. Several living plants were secured; these have thriven, bloomed, and fruited under cultivation, and so I am enabled to publish an amended description. The point of interest is that, as Hooker hinted, the plant is not a *Ligusticum*, but an *Angelica*, and so the name must be changed to *Angelica trifoliata*.

Angelica trifoliata.

A tufted low-growing marsh plant with spreading flowering branches, 6 cm. or 7 cm. high, and creeping underground stems.

Stem (portion above ground) very short or 0, brown, covered with remains of old leaf-sheaths.

Leaves in very large specimens 7 cm. long, usually not more than half that length or smaller, trifoliate, pinnate or pinnate with ternate leaflets, with petioles as long as or longer than the rhachis; leaflets in one or two rather distant opposite pairs, simple or ternate, very variable in shape, showing many forms of transition from simple to compound leaves, rhombeo-orbicular, with cuneate base, flabelliform, cuneate or orbicular-cuneate, with upper usually rounded half of margin broadly serrate, sometimes trilobed, unequally bilobed or trifid, with cuneate base entire, coriaceous, green or brownish-green on upper surface, glaucous on undersurface; venation much reticulating, primary veins terminating in a small, swollen, pale apiculus at apex of each tooth; margins slightly recurved; petiolules semi-terete, channelled, from 6 mm. to 2 mm.; petioles semi-terete, narrow-channelled, sheathing base of flowering shoot and stem with a very broad sheath 4 mm. long, having broad pale-coloured membranous margin.

Umbels compound, 3- to 5-flowered, pedicels lengthening after flowering; with sheathing amplexicaul bracts similar in shape, &c., to the leaves but smaller, sometimes much reduced and linear.

Flowers 1·5 mm. to 2 mm. in diameter; calyx-limb very short, acute; petals white, emarginate at rounded apex or divided into two unequal lobes; styles 1 mm. long, erect, spreading.

Fruit 4·5 mm. long × 3 mm. broad, oblong, dorsally compressed, with three prominent ribs on middle third, and two coriaceous lateral wings, each 1·5 mm. broad.

Hab. Terrace of River Kowai, on right bank, altitude 690 m.; swampy ground, vicinity of Porter's Pass, altitude 900 m.: amongst *Sphagnum*.

The plant bloomed in cultivation at end of December, the flowers being of very short duration, and the fruit ripe by middle of February. The leaves smell rather like carrot when bruised. The other *Ligusticum*, marked with a query in the Handbook, *L. filifolium*, should also, I think, be referred to *Angelica*.

Art. XXXVI.—*Some Recent Additions to the Moss-Flora of New Zealand.*

By T. W. Naylor Beckett, F.L.S.

[Read before the Philosophical Institute of Canterbury, 20th November, 1898.]

The fourth part of Dr. V. F. Brotherus's work on "New Species of Australian Mosses," published early this year, contains descriptions of fifteen new species from New Zealand, collected by Mr. William Bell in Otago, Mr. D. Petrie in Auckland, and by myself in Canterbury. I have in this paper given his descriptions of these additions to our moss-flora, together with several other mosses now for the first time recorded from New Zealand.

Eucamptodon petriei, Broth., n. sp.

"*Dioicus;* valde robustus, rigidus, lutescens, nitidus; *caulis* 6 cm. altus, flexuosus, dichotome ramosus, dense foliosus; *folia* scariosa, patentia, stricta, valide canaliculato-concava, ovato-lanceolata, obtusa, superiora 7–7·5 mm. longa et c. 2·5 mm. lata, marginibus erectis integerrimis, limbata, limbo angustissimo, hyalino, apicem versus evanido, nervo tenuissimo, paulum ultra medium evanido, interdum obsoleto, cellulis elongatis, inter se valde porosis, basilaribus aureis, alaribus permultis, pachydermis, quadratis, fusco-aureis omnibus lævissimis. Cætera ignota.

"*Patria* (No. 641).—Teremakau Valley, Westland; *D. Petrie.*

"Species pulcherrima, distinctissima cum *E. macrocalyce*, C. Müll., comparanda, sed statura multo robustiore, foliis nervo tenuissimo præditis aliisque notis raptim dignoscenda.

"That moss from Tasmania which my friend A. Geheeb, under the name of *Dicnemon moorei*, Broth. Geh., mentions in 'Revue Bryologique,' 1897, p. 67, I have by a further examination found to be *Campylopus kirkii*, Mitt., earlier found in New Zealand."—"New Species of Australian Mosses," by

V. F. Brotherus, part iv., p. 74, in Ofversigt af Finska Vet.-Soc. Foerh., 1898.

Dicranum platycaulon, C. Müll., n. sp., in Herb. Helms, No. 71.

"A *D. billardieri* limbo hyalino latiore diffeore videtur."—V. F. Brotherus. *D. bellii*, Broth. in litt. ad W. Bell.

Hab. On the ground, in forests, at roots of trees. Westland: *Helms.* Otago: Mount Cargill, near Dunedin; *D. Petrie:* No. 640, det. Brotherus Canterbury: Patterson's Creek, Mount Torlesse; *Beckett:* No. 494, det. Brotherus.

Dicranum polysetum, Hampe in Linnæa, 1859, p. 629.

Very abundant in "black-birch" forests (*Fagus cliffortioides*). Otago: Lake Te Anau; *D. Petrie:* No. 644, det. Brotherus. Mount Cargill; *W. Bell:* Stewart Island; *W. Bell:* det. V. F. Brotherus in litt.

Found also in Victoria, Australia.

Ditrichum blindioides, Broth., n. sp.

"Gracile, cæspitosum, cæspitibus densis, ad 6 cm. usque altis, inferne fuscescentibus superne saturate viridibus, nitidiusculis; *caulis* tenuis, erectus, flexuosus densiuscule foliosus, dichotome ramosus; *folia* falcata, canaliculato-concava, e basi lanceolata, sensim longissime setacea obtusa, marginibus erectis, integris, nervo basi c. 0·10 mm. lato, usque ad apicem a lamina distincto, cellulis ubique elongate rectangularibus, chlorophyllosis, lævissimis, alaribus nullis. Cætera ignota.

"*Patria.*—New Zealand: Auckland; *D. Petrie.* Sub numero 712 misit amicissimus T. W. Naylor Beckett.

"Species peculiaris, habitu *Blindiam* referens sed ob folia cellulis alaribus nullis prædita ad *Ditrichum* gerenda."—V. F. B., op. cit., p. 76.

Ditrichum glaucescens (Dicks), Hpe.

Otago: Mount Ida, altitude 3,000 ft.; *D. Petrie:* No. 663, det. V. F. Brotherus.

A European and North American moss.

Cheilothela.

I am indebted to Mr. A. Gepp, of the British Museum, for the following translation from the original Swedish of Dr. S. O. Lindberg's description of his new genus *Cheilothela* in "Utkast till en naturlig.," 1878:—

"*Ditricheæ* includes *Bryoxiphium,*, *Swartzia*, *Ditrichum*, *Pleuridium*, and *Archidium*. To these is now joined this new genus, *Cheilothela*, with the single species *Ch. chloropus* (*Ceratodon*, Brid.), occurring in Italy and Southern France—

a genus which can in no wise be compared with *Ceratodon*, by reason of the channelled, and, in the dry state, erect and appressed, leaves, with strong flattened-out and not limited nerve, forming the uppermost acute dagger-like part of the leaf; the small quadrate cells, with both upper and lower ends lip-formed, protruded exactly as in *Swartzia*, or a multitude of the *Bartramiaceæ;* perichætial bracts which are never reduced to mere basal-scales, the perfect *Trichostomum*-like peristome, &c. Similarly it can be little referred to the *Tortuleæ*, but it is to be considered in the light of a link between *Swartzia* and *Ditrichum*."

Cheilothela novæ-seelandiæ, Broth.

"*Dioica;* cæspitosa, cæspitibus densis, rigidis, fuscescenti-viridibus; *caulis* usque ad 3 cm. altus, erectus, inferne nudus, parce radiculosus, superne dense foliosus, dichotome vel fasciculatim ramosus; *folia* sicca imbricata, apice incurvula, humida erecto-patentia, inferiora minuta, superiora ovato-lanceolata, longe et anguste acuminata marginibus erectis, integerrimis, ob mamillas cellularum scabridis, nervo crasso, basi usque ad 0·15 mm. lato, excurrente, cellulis minutis, quadratis, valde mamillosis, obscuris, basilaribus oblongis, lævibus; *bracteæ perichætii* internæ e basi longe vaginante subito subulato-acuminatæ; *seta* 1·5–2·5 cm. alta, flexuosula, lutea, lævissima; *theca* suberecta, oblonga, curvatula, pallide fusca, ætate fusca, lævis nitidiuscula; *annulus* 0; *peristomium* simplex, dentibus c. 0·5 mm. longis, usque ad basin in cruribus duobus filiformibus aurantiacis, minute papillosis divisis; *spori* 0·01–0.012 mm., ochracei, lævissimi; *operculum* rubrum, e basi conica oblique subulatum; *calyptra* cucullata, dimidiam partem thecæ haud superans.

"*Patria.*—New Zealand—Otago: Blue Mountains (*D. Petrie*, sub No. 664 com. amicissimus T. W. Naylor Beckett): Diamond Lake ad rupes siccas, Queenstown et Kinloch ad terram siccam, Mungatui in fissuris rupium; *W. Bell.* [Also Kelly's Creek, Westland; *T. W. N. B.*]

"Species distinctissima a *Ch. chloropode* (Brid.), Lindb., theca lævi, annulo nullo, peristomii dentibus minute papillosis nec non operculo e basi conica oblique subulato facillime dignoscenda.

"Hereto belongs in all probability that species from the Bay of Islands which in the 'Handbook of the New Zealand Flora,' ii., p. 418, is with hesitation referred to *Trichostomum strictum*, Bruch. (Fl. N.Z., ii., p. 72)."—V. F. B., op. cit., p. 76.

Tortula submutica, Broth., n. sp.

"*Autoica;* cæspitosa, cæspitibus densiusculis, sordide fuscescentibus; *caulis* usque ad 1 cm. altus, erectus, basi

radiculosus, dense foliosus, dichotome ramosus; *folia* sicca curvulo-adpressa, comalia rarius indistincte contorta, humida erecto-patentia, carinato-concava, oblonga vel lineari-oblonga, obtusa vel acutiuscula, nervo excedente brevissime mucronata, marginibus ubique erectis, integerrimis, nervo rufescente, superne latiore, in mucronem robustum, brevem, acutum, apice sæpius hyalinum excedente, dorso lævi, cellulis subrotundis, dense et minute papillosis, obscuris, marginalibus in directione transversali latioribus, basilaribus oblongis vel breviter rectangularibus, hyalinis, lævissimis; *seta* 5 mm. alta, sicca superne sinistrorsum torta, lutescens; *theca* erecta, oblongo-cylindrica, fuscidula, sicca lævis; *annulus* simplex persistens; *peristomium* simplex aurantiacum, tubo basilari c. 0·04 mm. alto, dentibus filiformibus, liberis, erectis, brevibus, dense papillosis; *spori* 0·012 mm. lutei, læves; *operculum* anguste conicum, obliquum, obtusum, dimidiam partem thecæ adæquans, e cellulis in seriebus subrectis dispositis.

"*Patria.*—Otago: Lake Wakatipu et Anderson's Bay ad rupes siccas; *W. Bell.*

"Species *T. atrovirenti* (Sm.), Lindb., affinis, sed foliis comalibus vix contortis, marginibus ubique erectis nec non sporis duplo minoribus optime diversa."—V. F. B., op. cit., p. 79.

Tortula (Syntrichia) tenella, Broth., n. sp.

"*Dioica;* tenella, cæspitosa, cæspitibus densis nigrescenti-fuscescentibus; *caulis* 1 cm. altus, basi radiculosus, dense foliosus, simplex; *folia* sicca adpressa, humida suberecta, planiuscula, late oblonga, apice rotundata, pilifera, marginibus erectis vel superne læviter revolutis integerrimis, nervo crasso, rufescente, dorso lævi, in pilum elongatum, hyalinum, subintegrum producto, cellulis rotundato-hexagonis, 0·015–0·02 mm. chlorophyllosis minute papillosis, basilaribus rectangularibus, hyalinis; *seta* 7 mm. alta, crassiuscula, sicca superne sinistrorsum torta, pallide rubra; *theca* erecta, cylindrica, fuscidula; *annulus* duplex longe persistens; *peristomium* simplex, sordide lutescens, demum albidum, tubo basilari alto, cruribus elongatis, filiformibus papillosis; *spori* 0·012–0·015 mm. olivacei sublæves; *operculum* anguste conicum, acutum.

"*Patria.*—Central Otago; *D. Petrie.* Sub No. 822 com. amicissimus T. W. Naylor Beckett.

"Species distinctissima, inter *Syntrichias* piliferas tenerrima, cum nulla alia commutanda."—V. F. B., op. cit., p. 80.

Funaria (Eufunaria) subcuspidata, Broth., n. sp.

"*Autoica;* gregaria, pallida; *caulis* 2–3 mm. altus, erectus, infima basi radiculosus, simplex; *folia* inferiora perpauca, minuta, comalia multo majora, erecto-patentia concavius-

cula, subelliptica vel obovato-elliptica, cuspidata, marginibus erectis, superne ob cellulas paulum prominentes valde indistincte obtuse serrulatis, nervo tenui, rufescente, infra apicem evanido, cellulis basilaribus breviter rectangularibus, superioribus ovali-hexagonis, marginalibus limbum indistinctum, hyalinum, e serie unica cellularum composito efformantibus; *seta* 5 mm. alta, stricta, tenuis, pallide rubra; *theca* erecta, symmetrica, cum collo sporangio æquilongo clavato-pyriformis, sublævis, collo ruguloso, pallida; *annulus* 0; *peristomium* duplex; *exostomii* dentes 16, rubri, lanceolato-subulati, c. 0·3 m. longi et c. 0·05 mm. lati, obliqui, alte lamellati, lamellis c. 10, longitudinaliter striolati; *endostomium* sordide luteum, papillosum; *processus* dentibus breviores, angusti; *spori* 0·022–0·025 mm., ferruginei, grosse verrucosi; operculum alte convexum, mamillatum, 0·57 mm. diam., cellulis in seriebus obliquis dispositis; calyptra pallida, longirostris, basi in laciniis duabus divisa.

"Sides of bridle-path, Lyttelton Hills; *T. W. N. B.*: n. 64.

"Species distinctissima, cum *F. cuspidata*, H. f. et W., comparanda, sed foliis nervo infra apicem evanido, theca anguste clavato-pyriformi jam dignoscenda."—V. F. B., op. cit., p. 83.

Funaria (Entosthodon) helmsii, Broth. et Geh., n. sp.

"*Autoica;* gregaria, viridis; *caulis* 3 mm. altus, erectus, infima basi radiculosus, simplex; *folia* inferiora perpauca, minuta, superiora multo majora, patentia, concaviuscula, oblongo-obovata, acutiuscula, marginibus erectis, superne serrulatis, nervo viridi, infra summum apicem evanido, cellulis basilaribus breviter rectangularibus, superioribus ovali-hexagonis; *seta* 5–7 mm. alta, strictiuscula, tenuis, pallide rubra; *theca* erecta, cum collo sporangio æquilongo anguste clavato-pyriformis, pallida, sicca sublævis, collo ruguloso; *annulus* 0; *peristomium* simplex; *exostomii* dentes 16, lanceolato-subulati, c. 0·17 mm. longi et c. 0·045 mm. lati, striolati, aurantiaci; *spori* 0·02–0·025 mm., ochracei, lævissimi; *operculum* planum, minutum, c. 0·5 mm. diam., cellulis in seriebus obliquis dispositis; *calyptra* pallida, vix inflata.

"*Patria.*—New Zealand [Westland]: Camp 10; *Helms.*

"Species *F. subcuspidatæ* m. simillima, sed foliorum forma, peristomio simplici, sporis ochraceis, lævissimis nec non operculo plano longe diversa."—V. F. B., op. cit., p. 84.

Funaria (Entosthodon) subattenuata, Broth., n. sp.

"*Autoica;* gregaria, pallide viridis; *caulis* ad 1 cm. usque altus, erectus, tenuis, infima basi radiculosus, simplex vel dichotome ramosus; *folia* inferiora remota, minuta, comalia multo majora, patula, planiuscula, oblonga, acuta, 2–3 mm.

longa et vix ultra 1 mm. lata marginibus erectis, integerrimis, nervo tenui, longe infra apicem evanido, cellulis basilaribus rectangularibus, superioribus oblongo-hexagonis, marginalibus angustioribus, limbum indistinctum, concolorem ex unica serie cellularum composito efformantibus; *seta* usque ad 1 cm. alta, tenuis, pallida; *theca* erecta vel subcernua, cum collo sporangio æquilongo anguste pyriformis, lævis, collo plicato, pallida; *annulus*, 0; *peristomium* simplex: *exostomii* dentes 16, lanceolato-subulati, 0·2 mm. longi, 0·05 mm. lati, aurantiaci, papillosi; *spori* 0·025–0·03 mm. lutei, papillosi; *operculum* convexum, mamillatum, 0·53 mm. diam. cellulis in seriebus rectis dispositis; *calyptra* ignota.

"*Patria.*—New Zealand—Canterbury: Arthur's Pass, 3,013 ft., loco paludoso; *T. W. N. Beckett*, No. 93.

"Species *F. attenuatæ* (Dicks.), Lindb. (*F. templetoni*, Sm.), affinis, sed foliis integerrimis, haud luteo-limbatis, operculo mamillato, cellulis e seriebus rectis dispositis nec non sporis luteis, majoribus jam dignoscenda. A *F. gracili* (H. F. et W.) species nostra jam longius recedit.—V. F. B., op. cit., p. 85.

Bryum (Eubryum) appressifolium, Broth., n. sp.

"*Dioicum;* cæspitosum, cæspitibus densis, rigidis, 1·5 cm. altis. lutescentibus, nitidiusculis; *caulis* erectus, strictus, basi radiculosus, densissime foliosus, cuspidatus, innovationibus singulis, brevibus, strictis; *folia* subæqualia sicca arcte imbricata, humida erecta, concaviuscula, ovato-lanceolata, nervo excedente aristata, marginibus ubique revolutis, integerrimis, haud limbata, nervo basi c. 0·06 mm. lato, in aristam elongatam, rigidam, integram excedente, cellulis, rhomboideo- vel oblongo - hexagonis, basilaribus breviter rectangularibus; *bracteæ perichætii* intime foliis multo minores e basi dilatata sensim acuminatæ marginibus erectis, enerves; *seta* 1·5–2·5 cm. alta, flexuosa, tenuis, purpurea; *theca* pendula, minuta, turgide pyriformis, collo theca breviore, sicca lævis, deoperculata sub ore haud constricta, demum atropurpurea; *annulus* 0·125 mm. latus duplex; *peristomium* duplex; *exostomii* dentes c. 0·66 mm. longi et c. 0·12 lati carnei, apice hyalini hyaline limbati, lamellis altis, c. 40; *endostomium* liberum, lutescens, minutissime papillosum; corona basilaris ad medium dentium producta; *processus* carinati perforati; *cilia* bina, bene evoluta, longe appendiculata; *spori* 0·007–0·008 mm. lutescenti-virides, lævissimi; *operculum* magnum, cupulatum, mamillatum, nitidum.

"*Patria.*—New Zealand—Mount Alfred et Kinloch, Rae's Junction; *W. Bell:* Alford Forest, South Canterbury; *T. W. N. Beckett*, No. 445: Kelso, Otago: *D. Petrie.*

"Species *Bryo alpino*, L., admodum similis, sed foliis longe et rigide aristatis jam dignoscenda."—V. F. B., op. cit., p. 87.

Bryum (Eubryum) lævigatulum, Broth., n. sp.

"*Dioicum;* gracile, cæspitosum, cæspitibus densis, inferne ferrugineis, superne læte viridibus, nitidiusculis; *caulis* fertilis humilis, longe radiculosus, apice foliosus, innovationibus singulis vel binis, 1 cm. altis, dense foliosis obtusis; *folia caulina* erecto-patentia, elongate oblonga, obtusiuscula, marginibus erectis, integerrimis, limbata, limbo e seriebus tribus cellularum composito, nervo crasso, rufescente, cum apice evanido, cellulis ovali- vel oblongo-hexagonis, basilaribus subrectangularibus, *innovationum* sicca imbricata humida erecto-patentia, subcymbiformi-concava, oblonga, marginibus erectis, superne minutissime serrulatis, limbata, limbo triseriato, nervo cum apice evanido vel in apiculum erectum excedente, cellulis ovali- vel oblongo-hexagonis, basilaribus subrectangularibus; *bracteæ perichætii* internæ foliis multo minores, lanceolatæ, archegonia numerosa includentes; *seta* vix 1·5 cm. alta, flexuosa, tenuis purpurea; *theca* horizontalis vel nutans, pyriformis, collo sporangium æquante, sicca lævis, deoperculata sub ore haud constricta demum rubra; *annulus* 0·1 mm. latus, per partes secedens; *peristomium* duplex; *exostomii* dentes c. 0·35 mm. longi et c. 0·09 mm. lati, lutei, apice hyalini, lamellis c. 20; *endostomium* liberum, sordide hyalinum, minute sed densissime papillosum; *processus* dentium longitudinis, carinati, anguste perforati; *cilia* rudimentaria; *spori* 0·015–0·017 mm. latescentes, lævissimi; *operculum* convexo-conicum, apiculatum.

"*Patria.*—New Zealand—Waingaro, Auckland; *D. Petrie.* Sub numero 817 com. amicissimus T. W. Naylor Beckett.

"Species *Br. lævigato*, H. f. et W., affinis, sed statura multo minore et peristomio ciliis rudimentaris raptim dignoscenda."—V. F. B., op. cit., p. 88.

Bryum (Eubryum) austro-bimum, Broth., n. sp.

Dioicum; cæspitosum, cæspitibus densissimis, 1–2 cm. altis, inferne fusco-tomentosis, fuscidulis, innovationibus viridibus, haud nitidis; *caulis* erectus, breviter ramosus, apice dense foliosus, innovationibus binis, brevibus, erectis, inferne remote, apice dense foliosis; *folia comalia* rigida sicca et humidia imbricata, late ovata, marginibus e basi ultra medium folii anguste revolutis, integris, limbata, limbo lutescente, e seriebus tribus cellularum composito, nervo crasso, basi rubro, in externis cum apice evanido, in internis breviter excedente, cellulis laxis, ovali- vel oblongo-hexagonis, basilaribus vinose rubentibus, subrectangularibus; *innovationum* eisdem comalibus similia, sed minora, nervo longius excedente; *bracteæ perichætii* internæ minutæ triangulari-lanceolatæ, nervo excedente longe aristatæ; *seta* 1–1·5 cm. alta, flexuosula,

tenuis, pallide fusca, nitidiuscula; *theca* pendula oblongo-pyriformis, collo theca breviore, sicca lævis, deoperculata sub ore haud constricta, sordide fusca; *annulus* 0·1 mm. latus, faciliter revolubilis; *peristomium* duplex; *existomii* dentes c. 0·4 mm. longi et c. 0·075 mm. lati, lutei, apice hyalini, lamellis altis, c. 20; *endostomium* liberum; *processus* late perforati; *cilia* terna, bene evoluta, longe appendiculata; *spori* 0·015–0·018 mm., lutescenti-virides læves; *operculum* cupulatum, acute apiculatum.

"*Patria.*—New Zealand: Mount Alfred (4,000 ft.–5,000 ft.), Otago; *W. Bell.*

"Species *Br. bimo*, Schreb., simillima sed inflorescentia dioica jam dignoscenda.—V. F. B., op. cit., p. 89.

Bryum austro-pallescens, Broth., n. sp.

"*Autoicum;* cæspitosum, cæspitibus densiusculis 2–3 cm. altis, viridibus vel lutescenti-viridibus haud nitidis; *caulis* erectus, fusco-tomentosus, apice dense foliosus, innovationibus singulis vel binis, usque ad 1.5 cm. altis, gracilibus, inferne laxiuscule, apice dense foliosis; *folia caulina* erecto-patentia, carinato-concava, oblongo-lanceolata, nervo excedente aristata, marginibus fere ad apicem valde revolutis, integris, limbata, limbo lutescente, 3–5 seriato, nervo rufescente, in aristam longam, strictam, integram producto, cellulis rhomboideo-hexagonis, basilaribus subrectangularibus, infimis vinose rubentibus; *innovationum* eisdem caulinis similia; *bracteæ perichætii* intimæ minutæ, lanceolatæ, acuminatæ; *seta* usque ad 4 cm. alta, flexuosa, apice cygnea, tenuis, rubra, nitidiuscula; *theca* pendula oblongo-pyriformis c. 4 mm. longa collo sporangio breviore, sicca lævis, deoperculata sub ore haud constricta, pallide fusca; *annulus* duplex 0·1 mm. latus, faciliter revolubilis; *peristomium* duplex; *exostomii* dentes c. 0·55 mm. longi et c. 0·075 mm. lati, lutei, apice hyalini, papillosi, lamellis 20–25; *endostomium* liberum, sordide lutescens, papillosum; *processus* carinati, late perforati; *cilia* terna bene evoluta, appendiculata: *spori* vix ultra 0·015 mm., lutescenti-virides, læves; *operculum* convexo-conicum, acute apiculatum.

"*Patria.*—New Zealand: Pine Hill et Kinloch, Otago; *W. Bell.*

"Species *Br. pallescenti*, Schleich., valde affinis, sed exostomii dentibus angustioribus, parte subulata angustissima nec non sporis minoribus, lævibus dignoscenda."—V. F. B., op. cit., p. 90.

Bryum (Eubryum) kirkii, Broth., n. sp.

"*Dioicum;* tenellum cæspitosum, cæspitibus densiusculis, humilibus, læte viridibus vel lutescenti-viridibus, haud nitidis;

caulis humillimus, basi fusco-radiculosus, innovationibus brevibus, erectis, subjulaceis; *folia* sicca imbricata humida erecta, cymbiformi-concava, ovato-lanceolata, nervo excedente aristata, marginibus erectis, integris, haud limbata, nervo crasso, lutescente, in aristam rigidam serrulatam excedente, cellulis laxis, rhomboideo-hexagonis, basilaribus breviter rectangularibus; *seta* 1·5 cm. alta, flexuosula, tenuis, rubra, superne lutea; *theca* nutans vel pendula, ovalis, collo brevi, crasso, siccitate rugoso, demum purpurea; *annulus* 0·11 mm. latus. faciliter revolubilis; *peristomium* duplex; *exostomii* dentes c. 0·55 mm. longi et c. 0·08 mm. lati, lutei, apice hyalini, lamellis c. 30; *endostomium* liberum hyalinum, papillosum; *processus* carinati, anguste perforati; *cilia* bina, bene evoluta, breviter appendiculata; *spori* 0·01–0·015 mm., ochracei, læves; *operculum* conicum, mamillatum.

"*Patria.*—New Zealand: Otarama, Kowai ad terram; *T. W. N. Beckett*, No. 517.

"Species a *Br. annulato*, H. f. et W., foliis nervo longe excedente et thecæ forma, a *Br. pachytheca*, C. M., cui thecæ forma accedit, mollitie et foliorium structura dignoscenda."—V. F. B., op. cit., p. 91.

Papillaria amblyacis, C. M.

Neckera amblyacis, C. Müll., in Linn., 1869–70, p. 521. *Meteorium amblyacis*, Mitt., in Trans. Roy. Soc. Vic., 1883, p. 82.

Westland: Kelly's Range; *T. W. N. B.* Marlborough: Pelorus Sound; No. 511, *J. Rutland*; det. V. F. Brotherus. Canterbury: Waimate; *T. W. N. B.*

This fine moss in general appearance much resembles *P. kermadecensis*.

Psilopilum bellii, Broth., n. sp.

"*Dioicum;* robustum, cæspitosum, cæspitibus mollibus, densis ad 4 cm. usque altis, sordide fuscescentibus, vel nigrescentibus; *caulis* erectus, infima basi radiculosus, inferne nudus, superne dense foliosus, simplex; *folia* sicca crispula, humida e basi erecta, patula, carinato-concava, e basi haud latiore oblongo-ligulata, obtusa, apiculata, c. 5·5 mm. longa et c. 1·5 mm. lata, marginibus erectis, e medio folii ad apicem argute inæqualiter serratis, nervo basi c. 0·2 mm. lato, infra summum apicem evanido, dorso superne dentibus nonnullis magnis prædito, lamellis usque ad 36, humilibus, e seriebus cellularum duabus vel tribus compositis, cellula marginali cæteris æquimagna, cellulis pellucidis, laxis rotundato-hexagonis, 0·02–0·025 mm., basilaribus subrectangularibus, omnibus lævissimis; *seta* vix ultra 1·5 cm. alta, crassa, flexuosa, pallide fuscescenti-rubra; *theca* erecta, compressula, asym-

metrica, rotundato-ovata, fusca, collo brevi, crasso, microstoma, gymnostoma; *operculum* conico-subulatum curvatulum; *calyptra* ignota.

"Planta mascula eisdem formineis similis, bracteis perigonii latissime obovatis, intimis multo minoribus.

"*Patria.*—New Zealand—Otago: Pine Hill, prope Dunedin, locis paludosis, et in Mount Cargill, locis paludosis; *W. Bell.*

"Species distinctissima cum *Ps. crispulo,* H. f. et. W., comparanda sed theca erecta, rotundato-ovata, gymnostoma prima scrutatione dignoscenda."—V. F. B., op. cit., p. 91.

Sciaromium bellii, Broth., n. sp.

"*Dioicum;* gracile, læte viride; *caulis* fluitans ramosus, ramis elongatis, ad 9 cm. usque altis, flexuosis, inferne nudis, superne dense foliosis, subpinnatim ramulosis, ramulis 1–2 cm. altis, curvatulis, dense foliosis, obtusis: *folia* erecto-patentia, homomallula, ovata, 1·7–1·9 mm. longa et 0·8–1 mm. lata, marginibus erectis, minutissime serrulatis, nervo viridi, basi c. 0·06 mm. lato, infra summum apicem evanido, cellulis oblongo-hexagonis, c. 0·02 mm. longis et 0·007–0·01 mm. latis chlorophyllosis, basilaribus majoribus, marginalibus angustissimis. limbum pluriseriatum, indistinctum efformantibus, omnibus lævissimis. Cætera ignota.

"*Patria.*—New Zealand—Otago: North-east Valley, in rivulis. et Southland, Lime Hills, in locis paludosis; *W. Bell.*

"My excellent friend Mr. T. W. Naylor Beckett has sent me, under No. 609, specimens from Tyson's Mill, Otago, which I only with hesitation can refer to the species described above. It is somewhat coarser, and the leaves are projecting, which gives it a different aspect. Nevertheless, when its anatomical structure does not show any difference I dare not yet describe it as a separate species."—V. F. B., op. cit., p. 101.

In the "Transactions of the New Zealand Institute," vol. vi., p. 210, the late Mr. J. Buchanan published a paper on the mosses of the Province of Wellington, New Zealand, containing five new species named by Dr. J. Stirton. Dr. Stirton informed me that he had received the mosses from Mr. Buchanan, but was unable to say in what publication he had described them. On referring the question to Mr. A. Gepp, of the Natural History Department, British Museum, he kindly instituted a search, and sent me the following extracts from the Trans. Nat. Hist. Soc. Glasgow. He added that he had failed to find in any periodical the description of three of them—viz., *Hypnum amiatum, Hypnum wellingtoni,* and *Weissia rufa.*

Grimmia buchanani, Stirton.

"Stems loosely tufted; leaves oblong amplexicaul, plane margined, laxly areolated, terminating abruptly in very long, green, nearly entire subulæ, which are composed almost entirely of the prolonged nerves; perichætial leaves longer and narrower at the sheathing bases, otherwise identical; fruitstalk curved; capsule ovate, regular, furrowed when dry, pale; lid conico-rostrate, oblique, more than half the length of the capsule; calyptra dimidiate, covering half the capsule; teeth deep-red at base, curved, bifid into long pale subulate points; inflorescence in all likelihood dioicous; antheridia not detected."—Dr. J. Stirton, in Pro. Nat. Hist. Soc. Glasgow, vol. ii. (1876), p. 187.

Dr. Stirton sent me this moss with the remark, "Dr. K. Müller refers *Grimmia buchanani* to another genus." I at once recognised it as *Dicranodontium flexipes*, Mitt., and Dr. Brotherus has confirmed my identification. Dr. Stirton does not possess specimens of the other mosses described below.

Since the above was written I have received from Dr. Karl Müller a copy of his Symbolæ ad Bryologiam Australis (Hedwigia, xxxvii., 1898), in which (p. 116) he describes this moss. He considers it a new species, and publishes it under the name *Angströmia* (*Campylopodium*) *buchanani*. He adds, "In Hb. Stirton sub nomine *Grimmiæ buchanani* ejusdem fuit. *Campylopodium* capillaceum (H. f. et W. sub *Dicrano*) insulæ septentrionalis caule dicranoideo fere pollicari uncinato primo visu distinguiter."

Tortula incurvidens, Stirton.

"Stems gregarious, short; leaves lanceolate, with plane entire margins, crisped when dry, texture dense, opaque above, pellucid and quadrangular at base, nerve strong, indistinct near the apex, which is somewhat cucullate; capsule red, erect, on a thick red seta; peristome arising from a basilar membrane, broad and prominent above the mouth of the capsule, irregular, rough with minute papillæ, and crossed by two or three septa, incurved when dry, converging into a cone when moistened; lid obliquely rostrate, subulate, nearly as long as the capsule; calyptra dimidiate, extending more than half-way down.

"Approaches in several of its characters to *Tortula ambigua*, but diverges in others."—Stirton, op. cit., p. 187.

Bryum contortum, Stirton.

"Dioicous, densely cæspitose; stem radiculose; lower leaves small, scattered, upper suddenly enlarged, closely imbricated in a moist state, contorted when dry, ovate-oblong, terminating in long smooth reflexed points formed by the

excurrent nerves, which are red in the substance of the leaves; margin slightly reflexed, not thickened, but composed of two or three rows of narrower cells than those of the rest of the pagina; seta long, stout, red; capsule red, pendulous, narrowly obconical; lid sharply conical, apiculate, deep-red, shining.

"Allied to *Br. obconicum.*"—Stirton, op. cit., p. 188.

Bryum bulbillosum, Montagne.

"Description of this moss in Müller's Synopsis (ii., p. 301) agrees pretty well with the character of the New Zealand moss, and, in the absence of any more definite indications, it has not been thought advisable to separate them."—Stirton, op. cit., p. 188.

ART. XXXVII.—*Notes on the New Zealand* Musci.

By ROBERT BROWN.

[*Read before the Philosophical Institute of Canterbury, 3rd August, 1898.*]

Plate XXXVIII. (in part).

Genus **Weissia,** Hedwig.

THIS genus is composed of species which have ovoid or ovoid-oblong capsules, oblique operculums, single peristomes, 16 teeth free to the base, without a medial line, entire or perforate, annulate or exannulate and cucullate calyptra.

The species are of various habits: some of them grow in small tufts on rocks or in crevices; others grow in dense patches on damp banks; one species was found by Mr. Donald Petrie growing in swampy ground near Mount Pembroke, and he has kindly consented to allow it to be recorded in this paper; it is named *Weissia petriei.* Nearly all the species have alpine or subalpine habits, although some of them are occasionally found near the sea-level.

In the "Handbook of the New Zealand Flora" five species of this genus have been described as belonging to New Zealand, two of which have been identified as being similar to European species—viz., *W. controversa* and *W. crispula.* I have seen no New Zealand example of the former species, although I have searched for it wherever I have been botanising; neither does it occur in the large herbariums of Mr. Bell and Mr. Wright, who have allowed me to examine their valuable collections. The plants originally identified as *W. controversa* were collected by Sir J. D. Hooker at the Bay of

Islands, and subsequently by Mr. Knight, near Auckland. There are no available records of its having been found in any other place in New Zealand. It is very doubtful if it has a habitat in the South or Stewart Islands, although the climatic conditions are most favourable.

The plant which I have identified with considerable doubt as *W. flavipes,* Hook. f. and W., in this paper, is the only one among the large collection of specimens which have been examined by me that comes near the *W. flavipes* described and figured in the "Flora Novæ Zelandiæ," vol. ii., t. 33, f. 2. In that work the teeth of the peristome are described and figured as being perforated at the base, whilst the plant adopted by me in this paper as *W. flavipes* has the teeth of the peristome entire. The leaves also differ slightly in their outline from the figures of the former plant. This plant may therefore be a different species.

I have been unable to collect specimens of *W. irrorata,* Mitt., or *W. contecta,* H. f. and W.; neither do they occur in the before-mentioned herbariums—indeed, no one appears to know anything about them.

The species described in this paper as *W. chrysea* is an exceedingly common and variable plant, the colour ranging from yellowish-green to a deep green, according to the locality where it grows. The former colour occurs when the habitat is on rocks, where the plants are subject to be often dried up; the other colour occurs when the habitat is on damp banks. It also varies not only in the size of the plants, but in the size of the capsules. This species has previously been partly described by Mr. T. W. N. Beckett as a *Blindia,* in the "Transactions of the New Zealand Institute," vol. xxv., page 270. It is evidently named thus in mistake, its capsule being oval, whilst in the genus *Blindia* the capsule is turbinate or subpyriform. As this plant was incomplete when originally described, I have completed the description, and have placed it in the proper genus.

Where the description of the generic characters is incomplete I have temporarily placed those plants in this genus as doubtful members of it, in order that they may be recorded.

In the plate the peristomes are more highly magnified than the other parts.

1. *W. acutifolia,* sp. nov. Plate XXXVIII., fig. 1.

Plants monœcious, perennial, brown below, green above, growing in dense tufts $\frac{3}{8}$ in. high, branched, fastigiate. *Leaves* small, imbricating round the stem, flexuous or recurving from an erect base, oblong-lanceolate, acuminate, or linear-concave. *Margins* entire. *Nerve* continued to the apex. *Upper areola* small, dense; *lower* oblong; slightly crisp when dry. *Peri-*

chætial leaves oblong-lanceolate, acute or acuminate; acrocarpous. *Fruitstalk* slender, $\frac{1}{4}$ in.–$\frac{5}{8}$ in. long. *Capsule* ovate. The plants being past maturity, neither the *peristome, operculum,* nor *calyptra* were found.

Hab. Crevices of limestone rocks, near Broken River. Collected by R. B.

2. *W. torlessensis*, sp. nov. Plate XXXVIII., fig. 2.

Plants monœcious, perennial, yellowish-green, about $\frac{1}{8}$ in. high, growing in loose tufts. *Stem* slender, branched, fastigiate. *Leaves* small, spreading or erecto-patent from an erect base, imbricating round the stem, lanceolate, tapering into an acute point, concave. *Margins* entire. *Nerve* continued to the apex. *Upper areola* small; *lower* quadrate; scarcely altered when dry. *Perichætial leaves* smaller than the upper ones, lanceolate, acute, otherwise similar to the others; acrocarpous. *Fruitstalk* slender, reddish, $\frac{3}{16}$ in. long. *Capsule* narrow, ovate, oblong. *Operculum* conico-rostrate. *Peristome* single. *Teeth* 16, free to the base, consisting of a single row of cells. *Calyptra* not found.

Hab. Damp banks, Mount Torlesse. Collected by R. B.

3. *W. waymouthii*, sp. nov. Plate XXXVIII., fig. 3.

Plants monœcious, perennial, yellowish-green, growing in small dense patches $\frac{1}{4}$ in. high, branched, fastigiate. *Leaves* imbricating, spreading or recurving from an erect base, linear- or oblong-lanceolate, obtuse, concave. *Margins* entire. *Nerve* ending below the apex. *Areola:* Upper, small, dense; lower, quadrate, small; crisp when dry. *Perichætial leaves:* Inner smaller than the outer one, linear-lanceolate, obtuse, in other respects similar to the other leaves; acrocarpous. *Fruitstalk* dark-red, $\frac{3}{8}$ in. long. *Capsule* ovate-oblong. *Operculum* conico-rostrate, about two-thirds the length of the capsule. *Peristome* fragile, single. *Teeth* 16, free to the base. *Calyptra* cucullate.

Var. *β*. Larger in all the parts.

Hab. On dripping rocks, Palmer's Pass. Var. *β*: At Kaikoura; January, 1898. Collected in both places by R. B. Named after Mr. Waymouth, of Hobart, a celebrated Tasmanian botanist.

4. *W. flavipes* (?), Hook. f. and W. Plate XXXVIII., fig. 4.

Plants monœcious, perennial, green, growing in dense tufts $\frac{1}{4}$ in. high, branched near the base, fastigiate. *Leaves* erecto-patent, imbricating, linear-lanceolate, acute, or minutely apiculate, very concave. *Margins* entire. *Nerve* pellucid, slightly excurrent. *Areola:* Upper, small, dense; lower, small, oblong; crisp when dry. *Perichætial leaves* erect, innermost smallest,

linear-lanceolate, acute in outline, otherwise similar to the stem leaves; acrocarpous. *Fruitstalk* pale, $\frac{3}{16}$ in. long. *Operculum* oblique, conico-rostrate, about half the length of the capsule. *Peristome* single. fragile. *Teeth* 16, free to the base. *Calyptra* cucullate.

Hab. Damp banks, Port Lyttelton hills; November, 1882: at Kaikoura; January, 1898: and at Otaihape, North Island. Collected by R. B.

5. *W. crispula* (?), Ludwig. Plate XXXVIII., fig. 5.

Plants monœcious, perennial, growing in yellowish-green tufts about $\frac{1}{4}$ in. high, branched near the base. *Branches* short, fastigiate. *Leaves* erecto-patent, incurving, imbricating round the stem, linear-subulate, minutely apiculate, upper half convolute. *Margins* entire, nerved to the apex. *Upper areola* small, dense; *lower* small, oblong; crisp when dry. *Perichætial leaves:* Innermost smallest, linear-subulate, minutely apiculate, upper half convolute; acrocarpous. *Fruitstalk* $\frac{3}{8}$ in. long. *Capsule* ovate-oblong. *Annulus* persistent. *Peristome* single. *Teeth* 16, free to the base. *Operculum* conico-subulate, three-quarters the length of the capsule. *Calyptra* cucullate.

Var. *β*. Leaves longer and more slender.

Hab. Damp rocks, Water of Leith, Dunedin; January, 1883: R. B. North-east Valley, Dunedin; 1886: W. Bell.

Var. *β*. Water of Leith: R. B.

Note.—The nerve in the perichætial leaves is not excurrent in this plant, as described in the "Handbook of the New Zealand Flora"; hence this may be possibly a different plant.

6. *W. webbii*, sp. nov. Plate XXXVIII., fig. 6.

Plants monœcious, perennial, growing in dense tufts, yellowish-green, about $\frac{1}{2}$ in. high, branched, fastigiate. *Leaves* closely imbricating, secund, ovate-lanceolate near the base, upper two-thirds tapering into a convolute, subulate point, subfalcate. *Margins* entire. *Nerve* running into the subulate point. *Upper areola* small, dense; *lower* linear; crisp when dry. *Perichætial leaves* erect, shorter than the upper ones, oblong-lanceolate, acuminate, sheathing; acrocarpous. *Fruitstalk* pale, $\frac{1}{4}$ in. long. *Capsule* ovate.

Hab. Damp rocks, Moa Creek; June, 1885. Collected by R. B.

7. *W. petriei*, sp. nov. Plate XXXVIII., fig. 7.

Plants diœcious, perennial, growing in dense dark-green tufts $\frac{3}{4}$ in. high, branched, fastigiate. *Leaves* erecto-patent, becoming nearly erect towards the apex, imbricating round the stem; lower half of the upper leaves ovate-lanceolate,

upper half subulate; middle ones subulate. *Margins* entire, concave. *Nerve* continuous. *Upper areola* dense; *lower* small, oblong; flexuous when dry. *Perichætial leaves* erect, lower half sheathing, upper half subulate; acrocarpous. *Fruitstalk* red, $\frac{5}{8}$ in. long. *Capsule* slightly obovate. *Operculum* oblique, conico-subulate, longer than the capsule. *Peristome* single. *Teeth* 16, lanceolate, free to the base, entire, perforated or occasionally slightly bifid. *Calyptra* cucullate, scarcely covering the operculum.

Hab. Marshy ground near Mount Pembroke; November, 1893. Collected by Donald Petrie, and named after him.

8. *W. brotherusii*, sp. nov. Plate XXXVIII., fig. 8.

Plants monœcious, perennial, growing in yellowish-green tufts 1 in. high, branched subdichotomously, fastigiate. *Leaves* imbricating round the stem, erecto-patent or nearly erect, lower half shortly oblong-lanceolate, adpressed, upper subulate. *Margins* entire. *Nerve* stout, continued to the apex. *Upper areola* small; *lower* linear-oblong; erect when dry. *Perichætial leaves* erect, inner one largest, base convolute, sheathing 2–2½ times longer than the subulate apex; acrocarpous. *Fruitstalk* yellow, slender, ¼ in. long. *Capsule* inclined, obliquely attached to the apex of the fruitstalk, ovate. *Operculum* stout, subulate, nearly half the length of the capsule. *Peristome* single. *Teeth* 16, free to the base, slender, entire. *Annulus* persistent. *Calyptra* cucullate.

Hab. Rocks, West Coast. Named after Dr. V. F. Brotherus, of Helsingfors.

9. *W. chrysea*, T. W. N. Beckett; K. Müller. Plate XXXVIII., fig. 9.

Plants monœcious, perennial, growing in dense tufts, yellowish-green, ½ in.–1½ in. high. *Stems* branched, fastigiate. *Leaves* imbricating, secund; lower half convolute, sheathing; upper half contracted into a slender and curved point. *Margins* entire. *Nerve* occupying all the upper half of the leaves *Upper areola* small, dense; *lower* linear-oblong; upper half of leaves when dry spirally twisted. *Perichætial leaves* erect, larger than the upper ones, convolute, sheathing the fruitstalk, contracted to a slender point; acrocarpous. *Fruitstalk* pale, $\frac{5}{8}$ in. long. *Capsule* ovate-oblong. *Operculum* conic, acute, stout, one-third the length of the capsule. *Peristome* single, slender. *Teeth* 16, free to the base, membranous at the apex. *Calyptra* cucullate.

Hab. Damp rocks; very common on Mount Torlesse: R. B. Otarama: W. Bell and R. B. Kaikoura: R. B. Oamaru: R. B.

EXPLANATION OF PLATE XXXVIII. (IN PART).

Fig. 1. *Weissia acutifolia*, sp. nov.
1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle-stem leaf.

Fig. 2. *Weissia torlessensis*, sp. nov.
1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle-stem leaves.

Fig. 3. *Weissia waymouthii*, sp. nov.
1. Capsule.
2. Peristome.
3. Perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaf.
7. Lower leaf.

Fig. 4. *Weissia flavipes*, Hook. f. and W.
1. Capsule.
2. Peristome.
3. Perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaves.

Fig. 5. *Weissia crispula*, Ludwig.
1. Capsule.
2. Peristome.
3. Perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaf.
7. Lower leaf.

Fig. 6. *Weissia webbii*, sp. nov.
1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.

Fig. 7. *Weissia petriei*, sp. nov.
1. Capsule.
2. Peristome.
3. Perichætial leaf.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaf.

Fig. 8. *Weissia brotherusii*, sp. nov.
1. Capsule.
2. Peristome.
3. Perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaf.

Fig. 9. *Weissia chrysea*.
1. Capsule.
2. Peristome.
3. Perichætial leaf.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle-stem leaf.

ART. XXXVIII.—*Notes on New Zealand* Musci, *and Descriptions of New Species*.

By ROBERT BROWN.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plates XXXVIII. (in part) and XXXIX.–XLIV.

Genus **Mielichoferia**, Nees and Hornsch.

Mielichoferia is a genus of mosses having pyriform capsules, peristome single or gymnostomous, rarely being double, and calyptra cucullate. It has a close affinity with the genus *Bryum* in its habit and principal generic characters. In New

Zealand the genus is a small one. The first species of it discovered is recorded in the "Handbook of the New Zealand Flora," at page 437, as *M. longiseta,* which is a South American species. It was subsequently found on examination by Mr. Mitten that it differed from that plant. He has described it and named it *M. tenuiseta* at page 750 of the Handbook.

I have seen no specimens of the above-mentioned plant, nor of the one recorded as *M. eckloni* in a paper read by Mr. Beckett, and published in the "Transactions and Proceedings of the New Zealand Institute," vol. xxix., page 443. I have carefully compared the descriptions of *M. tenuiseta* and *M. eckloni* with the new species of this paper, and find the latter quite distinct from either of the above-named species. In the figures of *M. buchanani* the plant is one-half the magnification of the capsule and leaves.

M. buchanani, sp. nov. Plate XXXIX., fig. 10.

Plants monœcious, growing in dense patches $\frac{1}{2}$ in.–1 in. high, yellowish-green above, brown below. *Stem* $\frac{3}{16}$ in., radiculose, apex gemmiform, with a few scale-like leaves below; innovations fertile and barren, the fertile short, gemmiform, $\frac{1}{16}$ in., several of these preceding the barren ones; barren innovations slender, $\frac{1}{4}$ in.–$\frac{1}{2}$ in. long, with a few scale-like leaves below, above closely imbricating, fastigiate. *Stem leaves* few, small, closely imbricating, incurving at the apex; upper ones linear-lanceolate, acute; middle ones broader, concave; margins flat, with a few minute teeth at the apex; nerve disappearing below the apex. *Leaves* of barren innovations one-third longer than the fertile ones, linear-lanceolate, acute. *Areola* narrow-linear to the base; erect when dry. *Perichætial leaves:* Inner narrowest, linear-lanceolate, acuminate; acrocarpous. *Fruitstalk* flexuous, $\frac{3}{4}$ in. long, curved at the apex. *Capsule* clavate, pyriform, symmetrically inclined. *Operculum* small, conic. *Peristome* single. *Teeth* 16, irregular in outline, membranous, hyaline, united near the base. *Calyptra* not found.

Hab. Damp banks, Mount Torlesse; January, 1886. Selwyn Gorge; February, 1898. Collected by R. B.

Named in memory of the late John Buchanan.

Genus **Leptobryum**, Wils.

This is a small genus of annual mosses, having the same generic characters as the genus *Bryum*, their annual habit being the principal distinction. Two species of this genus occur in New Zealand—*L. pyriforme*, Wils., Plate XXXVIII., fig. 11, which is found in most countries, and *L. harriottii*, of this paper, which is a smaller plant than *L. pyriforme*, but quite

distinct, the capsule being smaller, and not so contracted at the apophysis. I have given figures of both species of the same magnification.

L. harriottii, sp. nov. Plate XXXVIII., fig. 12.

Plants diœcious, annual, growing loosely in small patches $\frac{1}{4}$ in. high, yellowish-green. *Leaves* loosely imbricating round the stem, erecto-patent, subfalcate or flexuous, linear-setaceous, semi-convolute; margins entire; nerve disappearing near the apex. *Areola* long and narrow, scarcely altered when dry; acrocarpous. *Perichætial leaves* small, setaceous, flexuous. *Fruitstalk* slender, $\frac{1}{2}$ in.–$\frac{3}{4}$ in. long, flexuous, slightly curved at the apex, pale-red. *Capsule* small, pendulous, shortly pyriform, not constricted at the middle, mouth small. *Peristome* double; outer teeth 16, free to the base, linear-lanceolate; inner united below to the middle; upper half divided into 16 teeth with intermediate cilia; membranous, hyaline. *Operculum* and *calyptra* not found.

Hab. In damp places, West Coast. Collected by R. B. Pine Hill, Dunedin; W. Bell.

Genus **Bryum**, Linn.

This is the largest genus of all the New Zealand acrocarpous mosses, and is composed of perennial plants, having a pendulous or inclined pyriform capsule; a double peristome, the outer one having 16 teeth, free to the base, the inner one a membrane divided to the middle into 16 keeled segments with or without intermediate cilia; calyptra cucullate.

It is also the most difficult to comprehend, through the close approximation of a large number of the species to each other in the form and size of their leaves, which are small and triangular in their outlines, and are only distinguished from each other with difficulty by variation in their length or breadth and other microscopic characters. The capsules, although more differentiated than the leaves in a number of them, closely approach others in form, thereby making the genus a very difficult one, and to determine the species without the aid of named specimens is almost impossible. Sir J. Hooker appears to have realised this difficulty, for he remarks in a note on the position of this genus, at page 437 of the "Handbook of the New Zealand Flora," that many of the New Zealand species are provisional only, and most of them require to be re-examined with more and better specimens. Their characters are often very obscure, and a reference to the figures of the species given in the first and second sections into which they have been divided in this paper will make the above remarks evident.

Since the publication of the Handbook several additions

have been made to the New Zealand *Bryums*, notably by Dr. V. F. Brotherus, of Helsingfors, who has described five new species in a paper read by him, and published in the Ofversigt af Finska Vet.-Soc. Förh.; bd. lv., Helsingfors, 1898—namely, *B. lævigatulum*, *B. austrobimum*, *B. austropallescens*, *B. kirkii*, and *B. appressifolia*. The first of the above species has been identified and described in the Handbook as the European *B. lævigatum*, and the second *B. bimum*, also European; but on being re-examined by Dr. Brotherus he has found them to differ from the European ones of that name, and has renamed them as above. He has kindly sent me his paper in which the new species are described. I regret very much that I cannot include them in this paper, through being unable to obtain authentic specimens of them, and there is also the possibility that they may be already in it.

In this paper the species are arranged in four groups, in order to facilitate their identification—Section 1, plants with small capsules and small leaves: section 2, capsules large and leaves small; section 3, leaves long and narrow; section 4, leaves broad.

All the figures of the species are of the same magnification.

Key to the Species.

Section 1. Capsules small, leaves small.

A. Margins entire, plain, nerve excurrent.
- Leaves linear-lanceolate, acuminate .. 3. *B. thomasii.*
- Leaves subdeltoid, acute .. .. 4. *B. waikariense.*
- Leaves oblong-lanceolate, acuminate .. 5. *B. otahapaense.*
- Leaves ovate-lanceolate, acuminate .. 6. *B. gibsonii.*
- Leaves lanceolate or oblong-lanceolate, acuminate .. .. .. 7. *B. ovatothecium.*
- Leaves lanceolate or oblong-lanceolate, acute .. .. 8. *B. webbii.*
- Leaves lanceolate or oblong-lanceolate, acute .. .. 9. *B. calcareum.*
- Leaves oblong-lanceolate, acuminate, toothed at apex .. .. .. 14. *B. ovatocarpum.*
- Leaves ovate-acute or acuminate, nerve subexcurrent .. .. .. 15. *B. ovalicarpum.*

B. Margins entire, recurved, nerve excurrent.
- Leaves lanceolate, acuminate .. .. 12. *B. buchanani.*
- Leaves ovate-lanceolate or oblong-lanceolate, acuminate .. .. .. 16. *B. webbianum.*
- Leaves ovate-lanceolate, acuminate .. 17. *B. cylindrothecium.*

C. Margins plain, entire, nerve disappearing below the apex.
- Leaves ovate-lanceolate or oblong-lanceolate, acute .. .. .. 1. *B. oamaruense.*
- Leaves ovate or oblong, acuminate .. 10. *B. argenteum.*

D. Margins entire, nerve ending at the apex.
- Leaves oblong-lanceolate, acute or acuminate .. .. 2. *B. oamaruanum.*
- Leaves deltoid, acute or acuminate .. 11. *B. petriei.*
- Leaves triangular, acute .. .. 13. *B. triangularifolium.*

Section 2. Capsules large, leaves small.

A. Margins entire, nerve excurrent.

Leaves linear-lanceolate, acute	19. *B. gracilithecium.*
Leaves subulate or linear-lanceolate, acute	20. *B. linearifolium.*
Leaves oblong-lanceolate, acute ..	22. *B. kirkii.*
Leaves oblong-lanceolate, acute ..	23. *B. bellianum.*
Leaves linear-lanceolate, acuminate ..	24. *B. macrocarpum.*

B. Margins entire, nerve ending at the apex.

Leaves oblong-lanceolate, acute .	21. *B. ventricosum.*

C. Nerve ending below apex, margins entire.

Leaves deltoid, acute	18. *B. harriottii.*
Leaves deltoid, obtuse	25. *B. hapukaense.*

Section 3. Leaves long, narrow.

A. Margins entire, nerve excurrent.

Leaves subulate-lanceolate, acuminate, margins entire, recurved	27. *B. tenuifolium.*
Leaves linear-lanceolate, acuminate, margins recurved, toothed at the apex ..	29. *B. evei.*
Leaves linear-lanceolate, acuminate, margins plain, toothed at apex.. ..	31. *B. bealeyense.*

B. Nerve continued to the apex.

Leaves subulate, acuminate, margins entire	26. *B. cockaynei.*
Leaves subulate, acuminate, margins toothed at the apex	30. *B. walkerii.*

C. Nerve ending below the apex.

Leaves linear-lanceolate, acuminate, margins serrated from the middle upwards	28. *B. binnsii.*

Section 4. Leaves broad.

A. Margins plain, nerve excurrent.

Leaves oblong-lanceolate, acute ..	36. *B. searlii.*
Leaves ovate-lanceolate, acute	37. *B. obesothecium.*
Leaves oblong-lanceolate, acuminate ..	44. *B. campylothecium.*
Leaves ovate or oblong-lanceolate, acute	40. *B. huttonii.*

B. Margins recurved, nerve excurrent.

Leaves ovate or oblong-lanceolate, acuminate	34. *B. torlessense.*
Leaves ovate-lanceolate, acuminate ..	35. *B. cuneatum.*
Leaves oblong-lanceolate, acute ..	38. *B. maudii.*
Leaves ovate-oblong, subacute, serrated at the apex	42. *B. billardierii.*
Leaves oblong-obovate or subspathulate, acuminate, toothed	43. *B. rufescens.*
Leaves oblong-obovate, acuminate, toothed at the apex	45. *B. truncorum.*
Leaves oblong, rounded at the apex, acute, minutely toothed	46. *B. gracilicarpum.*

C. Margins plain, nerve ending at the apex.

Leaves: Upper, oblong-acute; middle, ovate-acute	33. *B. heterofolium.*
Leaves ovate-lanceolate or oblong-lanceolate, subacute	39. *B. traillii.*
Leaves oblong-obtuse, nerve extremely slender at the apex	47. *B. blandum.*

D. Nerve ending below the apex.

Leaves ovate lanceolate, minutely serrated at the apex	32. *B. crudum.*
Leaves oblong-lanceolate, acute, minutely toothed at the apex	41. *B. eximium.*

SECTION 1.

Capsules small, leaves small.

1. *B. oamaruense*, sp. nov. Plate XL., fig. 13.

Plants small, monœcious, growing in small dense tufts about $\frac{1}{8}$ in. high, dark-green; innovations short, $\frac{1}{32}$ in., from 2 to 4. *Leaves* small, imbricating round the stem, middle and lower ones erecto-patent, upper erect, shortly ovate-lanceolate or oblong-lanceolate, acute, slightly concave; nerve vanishing below the apex; margins entire, plain. *Branch leaves* smaller, but otherwise similar to the stem ones. *Areola* subrotund, quadrangular near the base; dark-brown and twisted when dry. *Perichætial leaves* longer, the upper ones erect, oblong-lanceolate, acute, nerve vanishing below the apex; acrocarpous. *Fruitstalk* very short, arched at the apex. *Capsule* small, subpyriform, tapering into the fruitstalk and to the narrow mouth. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 teeth, hyaline. *Operculum* sharply conic. *Calyptra* cucullate.

Hab. On limestone rocks, near Oamaru; November, 1897. Collected by R. B.

2. *B. oamaruanum*, sp. nov. Plate XL., fig. 14.

Plants very small, growing in small loose patches $\frac{1}{16}$ in. high, pale-green; innovations few, extremely short. *Leaves* small, nearly erect, closely imbricating, shortly oblong-lanceolate, acute in the lower and acuminate in the upper ones, concave; margins entire, plain, nerved to the apex. *Areola:* Upper, trapezoid; lower, quadrate; when dry erect. *Perichætial leaves* smaller than the upper ones, lanceolate, acute; acrocarpous. *Fruitstalk* inclined, slender, $\frac{3}{16}$ in. long, scarcely curved at the apex. *Capsule* horizontal, small, ovate, contracted at the mouth. *Peristome* double; outer teeth 16, narrow-lanceolate, free to the base; inner shorter than the outer, a membrane divided to the middle into 16 cilia, alternating with the outer. *Operculum* narrow, small, mamillate. *Calyptra* not found.

Hab. Limestone rocks, near Oamaru; November, 1897. Collected by R. B.

3. *B. thomasii*, sp. nov. Plate XL., fig. 15.

Plants growing in small patches $\frac{1}{8}$ in.–$\frac{3}{16}$ in. high. *Stem* $\frac{1}{16}$ in., gemmiform; innovations $\frac{3}{16}$ in., fastigiate. *Leaves* small, imbricating round the stem, erecto-patent, linear-lanceolate, acuminate; margins entire, plain; nerve excurrent, aristate. *Areola:* Upper, trapezoid; lower, oblong. *Innovation leaves* small, subulate. *Perichætial leaves* smaller than the upper ones, linear-lanceolate, acute, nerved to the apex; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in. long, curved at the apex.

Capsule small, pendulous, pyriform, narrowed into the fruit-stalk, and very contracted at the mouth. *Peristome* double, outer teeth 16, free to the base; inner, a membrane divided into 16 processes to the middle. *Operculum* very small, convex, apiculate. *Calyptra* not found.

Hab. Styx Marsh, on wet ground; October, 1898. Collected by R. B.

Named after Dr. Thomas, late President of Philosophical Institute of Canterbury.

4. *B. waikariense*, sp. nov. Plate XL., fig. 16.

Plants extremely small, growing in small gregarious patches $\frac{3}{32}$ in. high. *Stem* $\frac{1}{32}$ in.; innovations $\frac{1}{16}$ in., pale-green, barren. *Leaves* erecto-patent, imbricating, small, subdeltoid, acute; margins entire, plain, nerved to the apex. *Innovation leaves* small, lanceolate, acuminate; nerve excurrent; margins entire. *Areola* small, subtrapezoid, quadrate at the base; when dry erect and adpressed. *Perichætial leaves* one-half smaller than the upper ones, deltoid, nerved to the apex; acrocarpous. *Fruitstalk* flexuous, $\frac{3}{16}$ in. long, curved at the apex. *Capsule* small, oval. *Operculum* convex, minutely apiculate. *Calyptra* not found.

Hab. On damp banks; April, 1882. Collected by R. B.

5. *B. otahapaense.* Plate XL., fig. 17.

Plants slender, diœcious, growing in small patches about $\frac{1}{4}$ in. high, dark-green. *Stem* $\frac{1}{8}$ in.–$\frac{1}{4}$ in., slender; innovations erect, 2 or 3, slender. *Leaves* erecto-patent, imbricating round the stem; upper ones oblong-lanceolate, long-acuminate; middle, oblong-lanceolate, acuminate; margins entire, plain; nerve excurrent, toothed at the apex. *Areola:* Upper, trapezoid; lower, quadrate; leaves erect when dry. *Perichætial leaves* smaller, ovate, acuminate; nerved to the apex; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in.–$\frac{3}{4}$ in. long, inclined shortly, curved at the apex. *Capsule* small, oval. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 teeth, alternate with the outer. *Operculum* conic.

Hab. On damp banks, near Otahape, North Island; March, 1895. Collected by R. B.

6. *B. gibsonii*, sp. nov. Plate XL., fig. 18.

Plants growing in dense patches, green above, dark-brown below, 1 in. high, slender. *Stems* nearly simple. *Leaves* erecto-patent, imbricating round the stem; lower ones distant, shortly ovate-lanceolate, acuminate, slightly concave; margins entire, plain; nerve excurrent, entire or slightly toothed. *Innovation leaves* small, linear-lanceolate, acute. *Areola:* Upper, trapezoid; lower, hexagonal; leaves slightly

crisp when dry. *Perichætial leaves* smaller than the upper, subulate-lanceolate, acuminate; nerve excurrent; acrocarpous. *Fruitstalk* slender, $\frac{1}{2}$ in. long, inclined shortly, curved at the apex. *Capsule* small, clavate, pyriform, shortly tapering into the fruitstalk, and slightly curved at the base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 segments with intermediate cilia. *Operculum* convex, apiculate. *Calyptra* not found.

Hab. On damp banks near Kaikoura; January, 1898. Collected by R. B.

Named after Walter Gibson, Kaikoura.

7. *B. ovatothecium*, sp. nov. Plate XL., fig. 19.

Plants growing in small yellowish-green patches about $\frac{1}{2}$ in. high. *Stem* short, $\frac{3}{8}$ in.–$\frac{1}{4}$ in.; innovations cæspitose. *Leaves* erecto-patent, closely imbricating all round the stem, lanceolate or oblong-lanceolate, acuminate, concave; margins entire, plain; nerve excurrent, aristate. *Innovation leaves* shortly ovate-lanceolate, acuminate; nerve excurrent. *Areola:* Upper, trapezoid quadrate at the base; leaves erect when dry. *Perichætial leaves* small, subulate-lanceolate, acute; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in. long, slightly curved at the apex. *Capsule* small, ovate, shortly tapering obliquely into the fruitstalk. *Peristome* double; outer teeth 16, free to the base, linear-lanceolate; inner, a membrane divided to the middle into 16 segments, alternate with the outer. *Operculum* small, convex, apiculate. *Calyptra* not found.

Hab. On damp banks, Port Lyttelton hills; April, 1882. Collected by R. B.

8. *B. webbii*, sp. nov. Plate XL., fig. 20.

Plants growing in small close patches, yellowish-green, $\frac{1}{4}$ in.–$\frac{5}{8}$ in. high. *Stem* $\frac{3}{16}$ in.; innovations slender, 1–4. *Leaves* small, erecto-patent or nearly erect, imbricating all round, lanceolate or ovate-lanceolate, acute; margins entire, plain; nerve excurrent, concave. *Innovation leaves* smaller, ovate-acute. *Areola:* Upper trapezoid, quadrate at the base; erect when dry. *Perichætial leaves* slightly smaller, lanceolate-acute; acrocarpous. *Fruitstalk* slender, slightly flexuous, $\frac{3}{8}$ in. long, curved at the apex. *Capsule* small, ovate-pyriform, tapering shortly into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, shorter than the outer, and alternate with them. *Operculum* conic, apiculate. *Calyptra* not found.

Hab. On damp banks, near River Ashburton, and at Governor's Bay, Port Lyttelton. Collected by R. B.

9. *B. calcareum*, sp. nov. Plate XL., fig. 21.

Plants growing in small patches ¼ in. high, yellowish-green. *Stems* short, ⅛ in.; innovations few, $\frac{3}{16}$ in. *Leaves* small, erecto-patent, imbricating round the stem, lanceolate or shortly oblong-lanceolate, acute, concave; margins entire, plain; nerve excurrent. *Innovation leaves* smaller, shortly oblong-lanceolate, acute. *Areola:* Upper trapezoid, lower quadrate; erect when dry. *Perichætial leaves* small, linear-lanceolate, acute; nerve excurrent; acrocarpous. *Fruitstalk* slightly flexuous, ¼ in.–⅜ in., shortly curved at the apex. *Capsule* small, subpyriform, slightly gibbous on the back, horizontal, shortly tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, one-third shorter than the outer ones, alternating with them. *Operculum* conic. *Calyptra* not found.

Hab. On damp banks, Weka Pass. Collected by R. B.

10. *B. argenteum*, L. Plate XL., fig. 22.

Hab. On damp banks, stones, and old roofs of houses.

11. *B. petriei*, sp. nov. Plate XL., fig. 23.

Plants monœcious, growing in dense patches ½ in. high, yellowish-green. *Stem* ⅛ in.–¼ in.; innovations barren, fastigiate, ⅜ in. *Leaves* erecto-patent, imbricating round the stem, upper deltoid-acute or acuminate, middle ones ovate-acuminate, concave; margins entire, plain; nerve ending at the apex. *Innovation leaves* small, lanceolate, acuminate; nerve excurrent. *Areola:* Upper trapezoid, lower erect when dry. *Perichætial leaves* erect, smaller than the upper ones, ovate-acuminate; acrocarpous. *Fruitstalk* ⅜ in. long, curved at the apex. *Capsule* pendulous or horizontal, small, pyriform, constricted towards the base, narrowing at the mouth. *Peristome* double; outer teeth 16, free to the base, lanceolate-acuminate; inner, a membrane divided to the middle into 16 processes, alternating with the outer ones. *Operculum* and *calyptra* not found.

Hab. On damp banks, West Coast Road.

12. *B. buchanani*, sp. nov. Plate XL., fig. 24.

Plants monœcious, growing in loose patches ½ in.–1 in. high, yellowish-green. *Stem* ¼ in.; innovations barren, fastigiate, radiculose. *Leaves* erecto-patent, closely imbricating all round upper ones, lanceolate-acuminate, concave; margins entire, recurved to near the apex; nerve excurrent, aristate, middle ones ovate-lanceolate, acuminate. *Areola:* Upper trapezoid, lower quadrate; erect when dry. *Perichætial leaves* shorter than the upper ones, triangular, nerved to the apex.

Innovation leaves narrower than the upper ones; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in.–1 in. long, curved at the apex. *Capsule* broadly pyriform, constricted near the base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided into 16 processes to the middle. *Operculum* large, convex, apiculate or mamillate. *Calyptra* not found.

Hab. On banks, in the bed of the River Hapuka, near Kaikoura; January, 1898. Collected by R. B.

Named after the late John Buchanan, F.L.S.

13. *B. triangularifolium*, sp. nov. Plate XL., fig. 25.

Plants slender, growing in small patches, green, $\frac{1}{2}$ in.–$\frac{3}{4}$ in. high. *Stems* $\frac{1}{4}$ in.–$\frac{5}{8}$ in.; innovations barren, fastigiate, slender, cuspidate. *Leaves* imbricating all round, erecto-patent, triangular, acute, concave; margins entire, plain; nerve continued to the apex. *Innovation leaves* smaller than the upper, ovate, long, acuminate; nerve excurrent. *Perichætial leaves* small, triangular, acute. *Areola*: Upper trapezoid, lower quadrangular; leaves flexuous when dry; acrocarpous. *Fruitstalk* slender, $\frac{3}{4}$ in. long, curved at the apex. *Capsule* small, ovate, annulus persistent. *Peristome* double; outer teeth 16, free to the base, linear-lanceolate, tapering into a slender point; inner, a membrane divided into 16 processes to the middle, alternate with the outer ones. *Operculum* and *calyptra* not found.

Hab. On damp banks, near Otaihape, North Island. Collected by R. B.

14. *B. ovatocarpum*, sp. nov. Plate XL., fig. 26.

Plants monœcious, growing in small dense patches $\frac{1}{4}$ in. high, yellowish-green. *Stem* $\frac{1}{8}$ in.; innovations barren, fastigiate, $\frac{3}{16}$ in. *Stem leaves* few, erecto-patent, imbricating, small, oblong-lanceolate, acuminate; margins entire, plain; nerve excurrent, filiform, entire or minutely toothed at the apex; middle ones smaller. *Innovation leaves* very small, otherwise similar to the others. *Areola*: Upper trapezoid, lower quadrate; erect when dry. *Perichætial leaves* very small, tapering from a broad base to an acute apex; nerve continued to the apex; acrocarpous. *Fruitstalk* $\frac{1}{4}$ in. long, curved at the apex. *Capsule* pendulous, small, ovate, annulus persistent. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes. *Operculum* convex, apiculate, or mamillate. *Calyptra* not found.

Hab. Wet places, Governor's Bay, Port Lyttelton; November, 1889. Collected by R. B.

15. *B. ovalicarpum*, sp. nov. Plate XL., fig. 27.

Plants monœcious, growing in large dense patches $\frac{1}{2}$ in.–$\frac{3}{4}$ in. high, bright-green above, black below. *Stems* $\frac{3}{16}$ in.–$\frac{1}{4}$ in.;

innovations $\frac{3}{8}$ in. long, fastigiate. *Leaves* small, spreading, loosely imbricating all round the stem, short, ovate-acute or acuminate; margins entire, plain, very concave; nerve subexcurrent. *Innovation leaves* lanceolate, acute. *Areola:* Upper trapezoid, quadrate at the base; erect when dry. *Perichætial leaves*, innermost smallest, outer broadly ovate-acute; acrocarpous. *Fruitstalk* erect, $\frac{1}{2}$ in. long, curved at the apex. *Capsule* small, oval, pendulous. *Peristome* double; outer teeth 16, linear-lanceolate; inner, a membrane divided to the middle into 16 processes, shorter than the outer. *Operculum* small, conic. *Calyptra* cucullate.

Hab. Wet places, Christchurch; August, 1898.

This moss is rarely found in fruit here. Collected by R. B.

16. *B. webbianum*, sp. nov. Plate XLI., fig. 28.

Plants diœcious, growing in small patches $\frac{1}{4}$ in. high, yellowish-green. *Stem* very short, gemmiform; innovations $\frac{1}{8}$ in. *Leaves* nearly erect, ovate-lanceolate or oblong-lanceolate, acuminate; margins entire, slightly recurved at middle; nerve excurrent, apiculate, concave. *Innovation leaves* smaller, oblong-lanceolate, acuminate, aristate, hyaline; nerve excurrent. *Areola:* Upper trapezoid, lower quadrate; flexuous when dry. *Perichætial leaves* slightly smaller, deltoid-acute; nerve ending at the apex; acrocarpous. *Fruitstalk* slightly flexuous, $\frac{5}{8}$ in. long, slightly curved at the apex. *Capsule* small, clavate, pyriform, shortly tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conic. *Calyptra* not found.

Hab. On damp rocks, Waikari; April, 1882. Collected by R. B.

17. *B. cylindrothecium*, sp. nov. Plate XLI., fig. 29.

Plants growing in small dense patches $\frac{1}{2}$ in. high, yellowish-green. *Stems* $\frac{5}{8}$ in., gemmiform; innovations barren, fastigiate, $\frac{1}{4}$ in. long. *Leaves* nearly erect, shortly ovate-lanceolate, acuminate; margins entire, subrecurved; nerve excurrent, aristate, slightly toothed. *Innovation leaves* small, oblong-acuminate; nerve excurrent, aristate. *Areola:* Upper trapezoid, lower oblong; erect when dry. *Perichætial leaves* small and narrow, subulate, subpiliferous; acrocarpous. *Fruitstalk* $\frac{1}{4}$ in.–$\frac{5}{8}$ in. long, curved at the apex. *Capsule* pendulous, oblong-pyriform, shortly tapering at the base. *Peristome* double; outer 16 teeth free to the base; inner, a membrane divided to the middle into 16 processes. *Operculum* convex, apiculate. *Calyptra* not found.

Hab. Damp banks, Waikari; April, 1882. Collected by R. B.

SECTION 2.

Capsules large, leaves small.

18. *B. harriottii*, sp. nov. Plate XLI., fig. 30.

Plants growing in dense patches $\frac{3}{4}$ in. high, yellowish-green. *Stems* $\frac{1}{8}$ in.–$\frac{3}{8}$ in., gemmiform; innovations slender, barren, fastigiate, $\frac{3}{8}$ in. *Leaves* few, small, imbricating round the stem, erecto-patent, deltoid-acute, concave; margins plain, minutely toothed on the apex; nerve disappearing near the apex. *Innovation leaves* erect, very concave, subrotund, incurving at the apex; margins entire; nerve disappearing near the apex. *Areola:* Upper trapezoid, oblong below; unaltered when dry. *Perichætial leaves* smaller, otherwise similar to the upper; acrocarpous. *Fruitstalk* slightly flexuous, 1 in. long, curved at the apex. *Capsule* large, horizontal, pyriform, tapering from the middle into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided into 16 processes, alternate with the outer. *Operculum* small, conic. *Calyptra* not found.

Hab. On wet banks, near the Weka Pass; April, 1882. Collected by R. B.

19. *B. gracilithecium*, sp. nov. Plate XLI., fig. 31.

Plants growing in loose patches $\frac{3}{4}$ in. high. *Stem* $\frac{1}{4}$ in.–$\frac{3}{8}$ in., radiculose; innovations short, subfastigiate, $\frac{1}{2}$ in.–$\frac{1}{4}$ in. *Leaves* small, nearly erect, closely imbricating all round the stem, linear-lanceolate from a broad base, acute, slightly concave; margins entire, plain; nerve shortly excurrent. *Innovation leaves* subulate, very small. *Areola:* Upper trapezoid, lower quadrate; erect when dry. *Perichætial leaves* smaller than comal ones, otherwise similar; acrocarpous. *Fruitstalk* inclined, bent near the base, $\frac{5}{8}$ in. long, curved at the apex. *Capsule* long, narrow, clavato-pyriform, with a contracted mouth and tapering base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* small, conic, apiculate. *Calyptra* not found.

Hab. Damp banks, West Coast Road. Collected by R. B.

20. *B. linearifolium*, sp. nov. Plate XLI., fig. 32.

Plants growing in dense patches $\frac{7}{8}$ in. high, pale-green above, dark-brown below. *Stems* slender, $\frac{1}{4}$ in.; innovations barren, $\frac{3}{8}$ in.–$\frac{5}{8}$ in. long, slender, fastigiate. *Leaves:* Upper, subulate or linear-lanceolate, acute; margins entire, plain; nerve stout, excurrent; middle ones smaller. *Innovation leaves* similar to the stem ones. *Areola:* Upper trapezoid, lower oblong; erect when dry. *Perichætial leaves* smaller than the upper ones; acrocarpous. *Fruitstalk* erect, 1 in.–1$\frac{3}{4}$ in. long,

curved at the apex. *Capsule* large, clavato-pyriform, tapering into the base, horizontal. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* broader than the contracted mouth, conic. *Calyptra* not found.

Hab. On damp banks, near Kaikoura; January, 1898. Collected by R. B.

21. *B. ventricosum*, sp. nov. Plate XLI., fig. 33.

Plants slender, growing in small patches $\frac{3}{4}$ in.–1 in. high, yellowish-green. *Stems* $\frac{1}{4}$ in.; innovations slender, $\frac{1}{2}$ in. long, fastigiate. *Leaves* small, erecto-patent, imbricating round the stem, oblong-lanceolate, acute, slightly incurving at the apex, concave; margins entire, plain; nerve continued to the apex. *Innovation leaves* very small, otherwise similar to the others. *Areola:* Upper trapezoid, lower quadrate; leaves flexuous when dry. *Perichætial leaves* smaller, but similar to the others; acrocarpous. *Fruitstalk* slight, flexuous, $\frac{7}{8}$ in., shortly curved at the apex. *Capsule* large, horizontal, pyriform, ventricose, tapering from the middle into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* very small, subconic. *Calyptra* not found.

Hab. On wet banks, Kaikoura; January, 1898. Collected by R. B.

22. *B. kirkii*, sp. nov. Plate XLI., fig. 34.

Plants growing in dense patches $\frac{3}{4}$ in. high, yellowish-green above, brown below. *Stems* radiculose, $\frac{1}{4}$ in.–$\frac{3}{8}$ in.; innovations subfastigiate, $\frac{3}{8}$ in., fertile. *Leaves* small, erecto-patent, imbricating round the stem, oblong-lanceolate, acute; margins entire, plain; nerve excurrent, aristate; middle leaves narrower. *Innovation leaves* shorter, oblong-lanceolate, acute; nerve excurrent. *Areola:* Upper trapezoid, lower oblong; erect and twisted when dry. *Perichætial leaves* small, deltoid-acute, nerved to the apex; acrocarpous. *Fruitstalk* 1 in.–$1\frac{1}{2}$ in. long, scarcely curved at apex; *capsule* large, pyriform, slightly ventricose, tapering into a rounded base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* convex, apiculate. *Calyptra* not found.

Hab. Damp banks, Mount Torlesse; January, 1887. Collected by R. B.

23. *B. bellianum*, sp. nov. Plate XLI., fig. 35.

Plants growing in dense patches $\frac{3}{4}$ in. high, yellowish-green above, dark below. *Stem* $\frac{1}{4}$ in.; innovations barren, slender, $\frac{3}{8}$ in., fastigiate. *Leaves* erecto-patent, closely imbricating

round the stem, oblong-lanceolate, acute, incurving at the apex, slightly concave; margins entire, plain; nerve excurrent; middle ones shorter than the upper, otherwise similar. *Innovation leaves* ovate-lanceolate, acuminate; nerve excurrent. *Areola:* Upper trapezoid, quadrate below, erect when dry. *Perichætial leaves* small, subulate-acute; nerve excurrent; acrocarpous. *Fruitstalk* slender, 1 in. long, slightly curved at the apex, pyriform, ventricose, subrotund at the base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided into 16 processes, nearly free to the base, alternate with the outer. *Operculum* conic. *Calyptra* not found.

Hab. Wet banks, Waikari; April, 1882. Collected by R. B.

24. *B. macrocarpum*, sp. nov. Plate XLI., fig. 36.

Plants growing in dense patches 1 in.–1¼ in. high, bright-green above, brown below. *Stem* ¼ in., gemmiform; innovations fertile, ¼ in.–⅝ in., fastigiate. *Leaves* erecto-patent, closely imbricating all round, small, linear-lanceolate, acuminate, slightly concave; margins entire, plain; nerve excurrent, aristate. *Innovation leaves* long, acicular. *Areola:* Upper trapezoid, quadrate towards the base. *Perichætial leaves* shorter than upper ones, otherwise similar; acrocarpous. *Fruitstalk* slightly flexuous, 1½ in. long, scarcely curved at the apex. *Capsule* very large, horizontal or pendulous, clavato-pyriform, tapering from the middle into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, keeled, perforated, alternate with the outer. *Operculum* conic. *Calyptra* not found.

Hab. Damp banks, near Oamaru; November, 1897. Collected by R. B.

25. *B. hapukaense*, sp. nov. Plate XLI., fig. 37.

Plants monœcious, growing in small dense patches ¼ in.–½ in. high. *Stem* ⅛ in., naked below, gemmiform; innovations barren, $\frac{3}{16}$ in., fastigiate. *Leaves* erect, closely adpressed, imbricating, small, deltoid-obtuse, concave; margins entire, plain; nerve disappearing near the apex; middle ones suboval. *Innovation leaves* oval. *Areola:* Upper trapezoid, lower quadrate; unaltered when dry. *Perichætial leaves* smaller than the upper, lanceolate-obtuse; acrocarpous. *Fruitstalk* flexuous, ¾ in. long, curved at the apex. *Capsule* large, broadly pyriform, ventricose, slightly rounded at the base. *Peristome* double; outer teeth 16; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conic, acute. *Calyptra* not found.

Hab. Wet banks, River Hapoua, tributary of the River Hapuka, near Kaikoura; January, 1898. Collected by R. B.

Section 3.

Leaves long and narrow.

26. *B. cockaynei*, sp. nov. Plate XLII., fig. 38.

Plants monœcious, growing in small loose patches $\frac{1}{8}$ in.–$\frac{3}{16}$ in. high, yellowish-green. *Stem* small, $\frac{1}{8}$ in., gemmiform; innovations barren, $\frac{1}{8}$ in. *Leaves* erecto-patent, imbricating all round, subulate-acuminate; margins entire, plain, concave; nerve continued to the apex, but indistinct there. *Innovation leaves* lanceolate, acuminate or ovate-acuminate; nerve subexcurrent. *Areola:* Trapezoid to the base; leaves erect when dry. *Perichætial leaves* slightly narrower than the upper, otherwise similar; acrocarpous. *Fruitstalk* flexuous, $\frac{3}{16}$ in.–$\frac{3}{8}$ in., curved at the apex. *Capsule* small, pyriform, ventricose, slightly gibbous at the base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes. *Operculum* small, conic. *Calyptra* cucullate.

Hab. Limestone rocks, Weka Pass; April, 1882. Collected by R. B.

27. *B. tenuifolium*, H. f. and W. Plate XLII., fig. 39.

Hab. Wet banks, near Kaikoura; January, 1898. Collected by R. B.

28. *B. binnsii*, sp. nov. Plate XLII., fig. 40.

Plants monœcious, growing in loose patches $\frac{1}{2}$ in.–$2\frac{1}{2}$ in. high, pink-coloured. *Stem* very slender, $\frac{1}{4}$ in.–$\frac{3}{4}$ in.; innovations very slender, $\frac{1}{4}$ in.–$\frac{3}{4}$ in., variable in length. *Leaves* erecto-patent, imbricating all round, linear-lanceolate, acuminate, fragile; margins serrated from the middle to the apex; nerve slender, ending below the apex; middle ones smaller, otherwise similar. *Innovation leaves* small, secund, linear-lanceolate, acuminate. *Areola* narrow, trapezoid to the base; scarcely altered when dry. *Perichætial leaves* very small, subulate; acrocarpous. *Fruitstalk* slender, $\frac{3}{8}$ in.–$\frac{1}{4}$ in., flexuous, slightly curved at the apex. *Capsule* small, pyriform, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided for two-thirds of its length into 16 processes, alternate with outer. *Operculum* conic. *Calyptra* not found.

Hab. Wet banks, Stewart Island: collected by R. B. North-east Valley, Dunedin: W. Bell.

29. *B. evei*, sp. nov. Plate XLII., fig. 41.

Plants monœcious, growing in dense patches $1\frac{1}{2}$ in.–$2\frac{1}{2}$ in. high, yellowish-green above, brown below. *Stems* radiculose, $\frac{1}{2}$ in. long; innovations fertile fastigiate, $\frac{1}{2}$ in. long. *Leaves*

imbricating, erecto-patent, linear-lanceolate, acuminate; margins recurved, toothed near the apex; nerve excurrent, aristate; middle ones narrowly ovate-lanceolate, acute, aristate. *Areola* small, subrotund above, becoming linear below, leaves twisted when dry. *Perichætial leaves* small, oblong, rounded at the apex; nerve excurrent as a hair-point, as long as the leaves, with a small tooth at the apex on each side of the hair-point; acrocarpous. *Fruitstalk* $\frac{3}{4}$ in. long, arched at the apex. *Capsule* long, clavato-pyriform, tapering into the fruitstalk, horizontal. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 filiform processes. *Operculum* conic, apiculate. *Calyptra* not found.

Hab. On wet banks, Mount Torlesse; January, 1887. Collected by R. B.

30. *B. walkerii*, sp. nov. Plate XLII., fig. 42.

Plants diœcious, growing in loose patches $\frac{1}{2}$ in.–$\frac{3}{4}$ in. high. *Stem* slender, nearly simple, $\frac{1}{4}$ in.–$\frac{1}{2}$ in.; innovations very slender, $\frac{3}{8}$ in. *Leaves* imbricating round the stem, spreading, subulate, acuminate; margins flat, toothed at the apex; nerve continued to the apex. *Innovation leaves* smaller than the stem ones, flexuous. *Areola* linear to the base; scarcely altered when dry. *Perichætial leaves* very small, subulate; acrocarpous. *Fruitstalk* $1\frac{1}{2}$ in.–2 in. long, scarcely curved at the apex. *Capsule* pyriform, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, perforated. *Operculum* convex, apiculate. *Calyptra* not found. Male inflorescence on the apex of a simple plant.

Hab. Damp ground, near Mason's Bay, Stewart Island. Collected by R. B.

31. *B. bealeyense*, sp. nov. Plate XLII., fig. 43.

Plants monœcious, growing in patches $\frac{1}{2}$ in.–$\frac{3}{4}$ in. high, yellowish-green. *Stems* $\frac{3}{8}$ in., naked below, gemmiform above; innovations arising near the base, $\frac{1}{2}$ in., barren, fastigiate. *Leaves* nearly erect, imbricating round the stem, linear-lanceolate, acuminate; margins plain or subrecurved at middle, minutely toothed at the apex; nerve excurrent. *Areola* linear; leaves scarcely altered when dry. *Perichætial leaves* small, erect, linear-lanceolate, acuminate; acrocarpous. *Fruitstalk* bright-red, shining, flexuous, shortly curved at the apex. *Capsule* clavato-pyriform, tapering from the middle into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* convex, apiculate. *Calyptra* not found.

Hab. Marsh, on the hill at the back of the Bealey Hotel; February, 1889. Collected by R. B.

SECTION 4.

Leaves broad.

32. *B. crudum*, Schreb. Plate XLII., fig. 44.

Hab. On damp banks, Mount Torlesse. Collected by R. B.

33. *B. heterofolium*, sp. nov. Plate XLII., fig. 45.

Plants diœcious, growing in small dense patches 1 in. high, light-green above, dark-brown below. *Stems* ¼ in., gemmiform; innovations ¼ in.–½ in., fastigiate, barren. *Leaves* erecto-patent, imbricating all round; upper ones oblong-acute or elliptic-acute; middle ovate-acute, slightly concave; margins entire, plain, with a border of narrow cells to near the apex; nerve continued to the apex. *Innovation leaves* oblong-lanceolate, acute; nerve disappearing at the apex. *Areola:* Upper, trapezoid; lower, oblong; leaves erect when dry. *Perichætial leaves* very small, erect, subulate, nerved to the apex; acrocarpous *Fruitstalk* slender, 1 in.–1¼ in. long, scarcely curved at the apex. *Capsule* clavato-pyriform, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conic, apiculate. *Calyptra* not found.

Hab. On damp banks, near Otaihape, North Island. Collected by R. B.

34. *B. torlessense*, sp. nov. Plate XLII., fig. 46.

Plants synœcious, growing in dense tufts ½ in.–¾ in. high. *Stem* ¼ in., yellowish-green; innovations ¼ in., subfastigiate, fertile ones gemmiform, barren, cuspidate. *Leaves* nearly erect, imbricating all round, oblong-lanceolate and ovate-lanceolate, with a long acuminate point, concave; margins with a border of long narrow cells, recurved below, and sometimes toothed at the apex; nerve excurrent, aristate. *Innovation leaves* barren, very concave, small, oblong-lanceolate, acute; nerve excurrent, aristate. *Areola* trapezoid above, oblong near the base; erect and twisted when dry. *Perichætial leaves* small, ovate-acuminate, nerved to apex. *Fruitstalk* 1 in.–½ in. long, curved at the apex. *Capsule* pendulous, clavato-pyriform, tapering from the middle into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided for a third of the length into 16 cilia, alternate with the outer. *Operculum* convex, apiculate. *Calyptra* cucullate.

Hab. On damp ground, Mount Torlesse; January, 1886 and 1887. Collected by R. B.

35. *B. cuneatum*, sp. nov. Plate XLII., fig. 47.

Plants growing in patches $\frac{1}{2}$ in. high, green. *Stems* $\frac{1}{4}$ in., gemmiform; innovations radiculose, $\frac{5}{16}$ in., fastigiate. *Leaves* ovate-lanceolate, with a slender acuminate point, concave; margins entire, recurved; nerve excurrent; middle leaves largest. *Innovation leaves* ovate-acuminate; nerve excurrent. *Areola:* Upper narrow trapezoid, lower oblong near the base; twisted and erect when dry. *Perichætial leaves* small, linear-lanceolate, tapering into a long slender point; nerve excurrent; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in. – 1 in., bright-red, shortly curved at apex. *Capsule* pyriform, mouth wide, tapering from near the mouth into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to near the base into 16 fragile processes. *Operculum* wide, convex, apiculate. *Calyptra* not found.

Hab. Wet banks, River Hapuka, near Kaikoura; January, 1898. Collected by R. B.

36. *B. searlii*, sp. nov. Plate XLII., fig. 48.

Plants growing in small dense patches $\frac{1}{4}$ in. high, dark-green. *Stems* $\frac{1}{16}$ in., gemmiform; innovations $\frac{3}{16}$ in., fastigiate. *Leaves* erecto-patent, imbricating all round; upper shortly oblong-lanceolate, acute or acuminate; middle ones larger, ovate-lanceolate, acute; margins entire, plain; nerve excurrent and recurved at apex. *Innovation leaves* smaller, similar to the stem ones. *Areola:* Upper, trapezoid; lower, quadrate; leaves twisted and nearly black when dry. *Perichætial leaves* small, oblong-lanceolate, acuminate; nerve excurrent; acrocarpous. *Fruitstalk* $\frac{1}{2}$ in. long, curved at the apex. *Capsule* clavato-pyriform, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided for two-thirds of its length into 16 processes, alternate with the outer. *Operculum* convex, apiculate. *Calyptra* not found.

Hab. On damp rocks, near Kaikoura; January, 1898. Collected by R. B.

37. *B. obesothecium*, sp. nov. Plate XLIII., fig. 49.

Plants growing in dense tufts $\frac{3}{4}$ in.–2 in. high, green above, dark-brown below. *Stems* $\frac{1}{4}$ in.–$\frac{3}{4}$ in., radiculose, slender; innovations slender, fastigiate, barren, $\frac{1}{4}$ in.–$\frac{3}{4}$ in. *Leaves* loosely imbricating all round, erecto-patent, ovate-lanceolate, acute, slightly concave; margins entire, bordered by long narrow cells; nerve ending at the apex or excurrent. *Innovation leaves* nearly similar to the stem ones. *Areola:*

Upper trapezoid, quadrate below; flexuous when dry. *Perichætial leaves* small, inner deltoid, outer ovate-lanceolate, acute, nerved to the apex; acrocarpous. *Fruitstalk* 1 in.–1½ in. long, curved at the apex. *Capsule* stout, pyriform, curved near the base, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Calyptra* cucullate.

Hab. Swampy ground, Mount Torlesse; January, 1886. Collected by R. B.

38. *B. maudii*, sp. nov. Plate XLIII., fig. 50.

Plants monœcious, growing in dense patches 1½ in. high. *Stem* 1 in., radiculose; innovations fertile, ¾ in.–1 in. high. *Leaves* loosely imbricating round the stem, erecto-patent, concave; upper oblong-lanceolate, acute; middle ones ovate-lanceolate; nerve excurrent, aristate; margins entire, recurved, bordered with long narrow cells. *Innovation leaves* broadly ovate, acute. *Areola:* Upper trapezoid, oblong below; twisted when dry. *Perichætial leaves* small, subulate-lanceolate, acute; margins recurved; acrocarpous. *Fruitstalk* 2½ in. long, curved at the apex, slender. *Capsule* long, pyriform, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conico-rostrate. *Calyptra* not found. *Antheridia* terminal on innovations.

Hab. Marshy ground near Lake Manapouri.

39. *B. traillii*, sp. nov. Plate XLIII., fig. 51.

Plants diœcious, growing in dense tufts 2 in. high, yellowish-green. *Stem* ¾ in.; innovations fertile, ⅜ in., on the apex of which are developed the archegonia, which is repeated by each succeeding innovation, giving a moniliform appearance to the plants. *Leaves* imbricating closely round the stem, nearly erect; upper ones ovate-lanceolate or broadly oblong-lanceolate, subacute; middle ones oval or ovate subacute, very concave; margins entire, plain; nerve ending at the apex. *Areola* subtrapezoid to the base. *Perichætial leaves* very small, ovate-lanceolate, acute, nerved to the apex; not found in fruit.

Hab. Marshy ground, Waterfall Run, Stewart Island. Collected by R. B.

40. *B. huttonii*, sp. nov. Plate XLIII., fig. 52.

Plants growing in loose patches 2½ in.–3½ in. high, pale-green above, brown below. *Stems* radiculose, 1½ in.; innovations fertile, 1 in.–1½ in., radiculose, fastigiate. *Leaves* imbricat-

ing round the stem, spreading; upper ones ovate-lanceolate or oblong-lanceolate, acute or acuminate, very concave, nerved to the apex, excurrent in the uppermost as a slender point; margins entire, having a border with long narrow cells recurved below; middle ones ovate-acute, nerve subexcurrent. *Innovation leaves* very concave, oblong-lanceolate, subacute or obovate-acute, minutely apiculate, nerved to the apex. *Areola:* Upper trapezoid, oblong near the base. *Perichætial leaves* very small, ovate-acuminate; nerve excurrent; acrocarpous. *Fruitstalk* $1\frac{1}{2}$ in. long, curved at the apex. *Capsule* large, clavato-pyriform, subventricose, tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* mamillate. *Calyptra* not found.

Hab. Styx Marsh, near Christchurch, in water; October, 1895. Collected by R. B.

41. *B. eximium*, Mitt. Plate XLIII., fig. 53.

Plants diœcious, growing in loose patches 1 in.–4 in. high, pale-green above, dark-brown below. *Stems* 1 in.–$2\frac{1}{4}$ in., slender, radiculose; innovations fastigiate, 1 in.–$1\frac{1}{4}$ in. *Leaves* large, spreading, $\frac{1}{8}$ in.–$\frac{1}{4}$ in. long, loosely imbricating; upper ones oblong-lanceolate, acute; middle ones subacute, very concave; margins recurved below, bordered with long narrow cells minutely toothed at the apex; nerve disappearing below the apex. *Innovation leaves* oblong, round at apex; nerve disappearing below the apex. *Areola:* Upper trapezoid, lower oblong. *Perichætial leaves* small, linear-lanceolate, acute, minutely toothed at the apex; acrocarpous. *Fruitstalk* 2 in.–3 in. long, curved at the apex. *Capsule* oblong-pyriform, with a short tapering base. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided for two-thirds of its length into 16 processes, shorter than the outer, and alternate with them. *Operculum* conic. *Calyptra* cucullate.

Hab. Styx Marsh, near Christchurch, in water; November, 1897. Collected by R. B.

42. *B. billardierii*, Schwægr. Plate XLIII., fig. 54.

43. *B. rufescens* (?), H. f. and W. Plate XLIII., fig. 55.

Plants growing in dense tufts $\frac{1}{2}$ in. high, pale-green. *Stems* $\frac{3}{8}$ in. high; innovations $\frac{1}{8}$ in.–$\frac{3}{8}$ in. high, fertile, fastigiate. *Leaves* erecto-patent, imbricating, oblong-obovate or subspathulate, acuminate; margins with a border of narrow cells minutely toothed at the apex and recurved below the middle; nerve excurrent, aristate, curved, in the middle leaves subexcurrent. *Areola:* Upper trapezoid, becoming quadrate at the base; leaves twisted when dry. *Perichætial*

leaves small; inner, subulate; outer, linear-lanceolate, acuminate, aristate; acrocarpous. *Fruitstalk* inclined, $\frac{3}{4}$ in. long, curved at the apex. *Capsule* narrow, clavato-pyriform, shortly tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conic, acute.

Hab. On rocks or decayed wood, Port Lyttelton hills; November, 1886. Collected by R. B.

44. *B. campylothecium*, Taylor. Plate XLIII., fig. 56.

Plants growing in dense patches $\frac{1}{2}$ in. high, green. *Stems* $\frac{3}{8}$ in.; innovations barren, $\frac{3}{16}$ in., fastigiate. *Leaves* erecto-patent, imbricating round the stem; upper ones oblong-lanceolate, acuminate; middle ones subspathulate, acuminate; margins entire, with a border of linear cells recurving at the middle; nerve excurrent, as a long slender hair-point. *Areola:* Upper trapezoid, lower quadrate; leaves twisted when dry. *Innovation leaves* small, broadly subspathulate, apiculate. *Perichætial leaves* small, narrow, linear-lanceolate, with a long slender hair-point; nerve excurrent; acrocarpous. *Fruitstalk* $\frac{5}{8}$ in. long, curved at the apex. *Capsule* oblong-pyriform, scarcely tapering into the fruitstalk. *Peristome* double; outer teeth 16, free to the base; inner, a membrane divided into 16 processes, alternate with the outer ones. *Operculum* and *calyptra* not found.

Hab. Damp banks, Port Lyttelton hills; 1891.

45. *B. truncorum*, Bory. Plate XLIV., fig. 57.

46. *B. gracilicarpum*, sp. nov. Plate XLIV., fig. 58.

Plants growing in loose tufts $\frac{3}{4}$ in. high, green. *Stems* $\frac{1}{4}$ in.; innovations fertile, single, arising from the perichætium, $\frac{1}{4}$ in., gemmaceous. *Leaves* spreading, upper large, imbricating, oblong, rounded at the apex and shortly acute, concave; margins bordered with long narrow cells minutely toothed at the apex, recurved below; nerve excurrent, curved at the apex. *Areola:* Upper trapezoid, lower oblong; leaves twisted and erect when dry. *Perichætial leaves* small, triangular, tapering straight from a broad base, toothed at the apex, nerved to the apex; acrocarpous. *Fruitstalk* 1 in. long, curved at the apex. *Capsule* long and narrow, clavato-pyriform, tapering from the apex to the fruitstalk, inclined. *Peristome* double; outer 16 teeth free to the base; inner, a membrane divided to the middle into 16 processes, alternate with the outer. *Operculum* conic. *Calyptra* not found.

Hab. On rocks, Mount Torlesse; January, 1887. Collected by R. B.

47. *B. blandum*, H. f. and W. Plate XLIV., fig. 59.

Hab. On stones, near running water; on rocks, in the spray of waterfalls, Mounts Torlesse and Ben More; Kaikoura, near the River Hapuka; and on rocks, near the Sutherland Falls, in the spray. Collected by R. B.

Genus **Meesia**, Hedwig.

This genus has a great affinity with *Bryum*, through the pyriform capsules and double peristomes having the same number of teeth. The capsules of *Meesia*, however, differ from those of *Bryum* in their being more gibbous on the back, and in the mouth being more oblique. The peristome also differs from that of *Bryum* in the outer being shorter than the inner.

One species of this genus—*M. macrantha* (described in the "Handbook of the New Zealand Flora," page 444)—I regret I have seen no specimens of. I have carefully compared all the species described in this paper with the description of the above-named plant, and find that, although they all agree with it in being obtuse or round at the apex of the leaves and in the nerve ending below the apex, they all differ from it in other characters.

The five species described in this paper are of an aquatic habit, having been found growing in shallow running water, but not submerged; they all approach each other in the form of the leaves, the capsules being the principal distinguishing character.

I regret to have to state that some of the species have become extinct in the habitats given in this paper, their special habits making them very liable to be overgrown by other vegetation. The Mount Torlesse and Port Lyttelton hills habitats have been extinct for several years. The former has been overgrown by other plants; in the latter the plants grew on a flat rock over which water slowly moved, and, as this water was turned aside for domestic purposes, the rock dried and the *Meesias* on it perished.

The figures of the species are all of the same magnification.

1. *M. kirkii*, sp. nov. Plate XLIV., fig. 60.

Plants monœcious, growing in patches ½ in. high, pale-green above, nearly black below. *Stems* ¼ in., radiculose; innovations ¼ in., slender, fastigiate. *Leaves* nearly erect, imbricating round the stem, small, oblong, round at the apex, concave; margins entire, plain; nerve stout below, ending below the apex. *Innovation leaves* close, nearly erect, oblong,

round at the apex; nerve ending below the apex. *Areola:* Upper subquadrate, lower oblong; leaves twisted and erect when dry. *Perichætial leaves* erect, slightly broader, otherwise similar to the others; acrocarpous. *Fruitstalk* $\frac{5}{8}$ in. long. *Capsule* small, erect, pyriform, curved, gibbous on the back. rounded at the base, mouth slightly oblique; apophysis cuneate. Other parts not found.

Hab. Marshy ground near Lake Te Anau. Collected by R. B.

2. *M. craigieburnensis*, sp. nov. Plate XLIV., fig. 61.

Plants monœcious, growing in small dense patches $\frac{1}{2}$ in. high. *Stems* $\frac{3}{16}$ in., gemmiform; innovations $\frac{1}{8}$ in.–$\frac{3}{16}$ in., slender, gemmiform, subfastigiate. *Leaves* erecto-patent. imbricating all round, oblong, rounded at the apex, subacute, concave; margins entire, plain; nerve disappearing below the apex. *Innovation leaves* smaller, otherwise similar to the upper ones. *Areola* trapezoid near the apex, oblong below; leaves erect when dry. *Perichætial leaves* nearly as large as the upper ones, ligulate; nerve disappearing below the apex; acrocarpous. *Fruitstalk* erect, $\frac{3}{8}$ in.–$\frac{5}{8}$ in. long. *Capsule* erect, small, clavato-pyriform, unequal, constricted at the apophysis, which is short, oblong, round at the base; mouth scarcely oblique. *Peristome* double; outer teeth 16, short, irregular in outline, linear-lanceolate, obtuse; inner, very fragile or imperfect, half the length of the outer, and alternate with them. *Operculum* conic. *Calyptra* not found.

Hab. Marshy ground near Broken River; 1887. Collected by R. B.

3. *M. buchanani*, sp. nov. Plate XLIV., fig 62.

Plants monœcious, growing in very large patches $2\frac{1}{2}$ in. high, yellow above, brown below. *Stems* radiculose, $1\frac{3}{4}$ in.; innovations slender, $\frac{1}{2}$ in.–$1\frac{1}{2}$ in., fastigiate. *Leaves* erecto-patent, imbricating round the stem, ovate-lanceolate, round at the apex; middle ones smaller, otherwise similar to the upper, concave; margins entire, plain; nerve stout below, disappearing below the apex. *Innovation leaves* subulate, round at the apex, nerve disappearing. *Areola* narrow; leaves twisted and erect when dry. *Perichætial leaves* slightly larger, similar to the others; acrocarpous. *Fruitstalk* slender, 1 in. long. *Capsule* erect, clavato-pyriform, curved, constricted at the apophysis, gibbous at the base. *Peristome* double: having been destroyed by insects, full description cannot be given of it. *Operculum* oblique, subconic. *Calyptra* small, cucullate.

Hab. On wet rocks, Kennedy's Bush, Port Lyttelton hills; January, 1882. Collected by R. B.

4. *M. aquatica*, sp. nov. Plate XLIV., fig. 63.

Plants monœcious, growing in loose patches 1 in. high, yellowish-green above, brown below. *Stems* radiculose, ½ in.; innovations barren, slender, ½ in., subfastigiate. *Leaves* erecto-patent, imbricating round the stem, ovate-lanceolate, round at the apex; margins entire, plain; nerve ending below the apex; middle ones shortly ovate-lanceolate, round at the apex. *Innovation leaves* narrow ovate-lanceolate, round at apex. *Areola:* Upper subtrapezoid, longer below; crisp when dry. *Perichætial leaves* ovate-lanceolate, round at the apex; nerve ending below the apex; acrocarpous. *Fruitstalk* slender, 1½ in. long. *Capsule* pyriform, erect, slightly curved, gibbous on the back, slightly constricted at the apophysis, rounded to the fruitstalk. *Peristome* double; outer 16 short, præmorse; inner 16 slender, membranous, consisting of two rows of cells, keeled. *Operculum* oblique, conic. *Calyptra* cucullate.

Hab. In a small marsh near the source of the River Kowai, Mount Torlesse; January, 1887. Collected by R. B.

5. *M. aquatilis*, sp. nov. Plate XLIV., fig. 64.

Plants monœcious, growing in loose patches 2½ in. high, yellowish-green above, nearly black below. *Stems* 1¼ in., flaccid, slender; innovations slender, ⅜ in.–¾ in., fastigiate. *Leaves* erecto-patent, imbricating round the stem, large ovate-lanceolate, round at the apex, nearly flat; margins entire, plain; nerve stout below, disappearing below the apex; middle leaves shorter. *Innovation leaves* ovate-lanceolate, round at the apex. *Areola* subquadrate, longer below; leaves crisp when dry. *Perichætial leaves* longer, oblong-lanceolate or obovate-lanceolate, round at the apex; acrocarpous. *Fruitstalk* erect, 2 in. long. *Capsule* erect, broadly pyriform, curved, gibbous on the back, constricted at the apophysis, which is short and round at the base, mouth small, oblique. *Peristome* double; outer teeth 16, short, free to the base; inner 16 keeled, of two rows of moniliform cells. *Operculum* very oblique, small. *Calyptra* cucullate.

Hab. In a strip of marshy ground, near Broken River. Collected by R. B.

EXPLANATION OF PLATES XXXVIII. (IN PART) AND XXXIX.–XLIV.

Plate XXXVIII. (in part).

Fig. 11. *Leptobryum pyriforme*, Wils.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

PLATE XXXVIII. (IN PART)—*continued.*

Fig. 12. *Leptobryum harriottii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaves.

PLATE XXXIX.

Fig. 10. *Mielichoferia buchanani*, sp. nov.

1. Plant.
2. Capsule.
3. Peristome.
4. Perichætial leaves.
5. First leaf outside perichætial.
6. Upper leaves.
7. Middle leaf.

PLATE XL.

Fig. 13. *Bryum oamaruense*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. Upper leaves.
4. Calyptra.

Fig. 14. *B. oamaruanum*, sp. nov.

1. Capsule and plant.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 15. *B. thomasii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 16. *B. waikariense*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 17. *B. otahapaense*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaves.
6. Branch leaf.
7. Peristome.

Fig. 18. *B. gibsonii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 19. *B. ovatothecium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.

Fig. 20. *B. webbii*, sp. nov.

1. ———
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 21. *B. calcareum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

PLATE XL.—*continued.*

Fig. 22. *Bryum argenteum*, L.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaves.
6. Branch leaf.

Fig. 23. *B. petriei*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 24. *B. buchanani*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 25. *B. triangularifolium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 26. *B. ovatocarpum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaves.

Fig. 27. *B. ovalicarpum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

PLATE XLI.

Fig. 28. *Bryum webbianum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 29. *B. cylindrothecium*, sp. nov.

1. Capsule and operculum.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 30. *B. harriottii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Branch leaf.

Fig. 31. *B. gracilithecium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaves.
6. Branch leaf.

Fig. 32. *B. linearifolium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

PLATE XLI.—*continued.*

Fig. 33. *Bryum ventricosum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 34. *B. kirkii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 35. *B. bellianum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 36. *B. macrocarpum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaves.
6. Branch leaf.
7. Lower leaf.

Fig. 37. *B. hapukaense*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

PLATE XLII.

Fig. 38. *Bryum cockaynei*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 39. *B. tenuifolium*, H. f. and W.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaves.
6. Branch leaf.

Fig. 40. *B. binnsii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 41. *B. evei*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 42. *B. walkerii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 43. *B.*   sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.

Plate XLII.—*continued.*

Fig. 44. *Bryum crudum*, Schreb.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 45. *B. heterofolium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 46. *B. torlessense*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 47. *B. cuneatum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 48. *B. searlii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Lower leaf.
7. Branch leaf.

Plate XLIII.

Fig. 49. *Bryum obesothecium*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 50. *B. maudii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 51. *B. traillii*, sp. nov.

1. Perichætial leaves.
2. First leaf outside perichætial.
3. Upper leaves.
4. Middle leaf.
5. Branch leaf.

Fig. 52. *B. huttonii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

Fig. 53. *B. eximium*, Mitt.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 54. *B. billardierii*, Schwægr.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.

PLATE XLIV.—*continued.*

Fig. 55. *Bryum rufescens* (?), H. f. and W.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 56. *B. campylothecium*, Taylor.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.

PLATE XLIV.

Fig. 57. *Bryum truncorum*, Bory.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.

Fig. 58. *B. gracilicarpum*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 59. *B. blandum*, H. f. and W.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 60. *Meesia kirkii*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 61. *M. craigieburnensis*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 62. *M. buchanani*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Fig. 63. *M. aquatica*, sp. nov.

1. Capsule.
2. Peristome.
3. Perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle leaf.
7. Branch leaf.

Fig. 64. *M. aquatilis*, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper-stem leaf.
5. Middle leaf.

ART. XXXIX.—*On the Future of the New Zealand Bush.*

By Canon PHILIP WALSH.

[*Read before the Auckland Institute, 15th August, 1898.*]

IN a paper* read before the Auckland Institute two years ago I drew attention to the extensive and rapid disappearance of the native bush in many parts of the country, and endeavoured to trace the principal agents which combine in the work of destruction. It may be interesting to follow the subject a further stage, and attempt, by the observation of present facts, to forecast the future condition of the forest when something like a balance shall have supervened between the destructive agents on the one hand and the resilient power of nature on the other.

2. *Recapitulation.*

In order to present the matter clearly, it will be well to recapitulate the argument of the former paper.

The two principal destructive agents, besides the axe of the bushman, are fires and cattle, to which should be added the wild pig, or "Captain Cooker," as this animal does his full share. Any of these acting alone is sufficient to do a good deal of damage, but when they all act in conjunction, as they generally do, the destruction is greatly accelerated and intensified.

The whole of the forest below a moderate altitude throughout both Islands is more or less an open cattle- and pig-run, in which, by the browsing, trampling, and rooting of the animals, the undergrowth is gradually destroyed, the surface roots lacerated, and the soil trodden into mud, which in summer hardens almost into a bed of concrete. The consequence is that the larger trees, deprived of their accustomed nourishment and protection, grow thin and open at the top; the ground is covered with fallen leaves; the *débris* of centuries, now exposed to the sun and winds, is dried to tinder; and the whole place is ready to be swept by fire, which sooner or later inevitably happens.

In thickly settled districts, and in those where timber-getting is carried on, the destruction is most rapid and complete, as every clearing, timber-working, and road-line forms

* Trans. N.Z. Inst., 1896, Art. xliv., "On the Disappearance of the New Zealand Bush."

a starting-point for the fires, which spread into and kill some portion of the adjacent standing bush. And, as wherever the fire has once passed it will pass again while there is anything left to burn, before very long, in districts where clearings are frequent, the whole bush is consumed, with the exception, perhaps, of that which stands in the lower and damper situations, or which, from the conformation of the country, is protected from the sweep of the flames. In this way, in a comparatively few years, immense areas of magnificent forest have been entirely destroyed in many of the more settled districts, while in others the work is going on more or less rapidly and completely, according to the nature of the bush and the climatic and other conditions.

3. *How far will the Destruction extend, &c.?*

Now, the question is, How far will this destruction extend, and what will be the ultimate condition of the portion that escapes? It may be broadly stated: (1) That below a certain altitude, varying according to locality, climate, and aspect, wherever the soil is fairly fertile, the bush once removed will never reappear; (2) that in elevated and barren country, especially in cold and moist situations, the bush has a fair prospect of remaining practically in its virgin condition; (3) while between the two the battle will be fought with varying success, and that, though considerable portions will escape extinction, they will undergo a gradual but very complete alteration in character and appearance. Each of these propositions may be considered in detail:—

(1.) In open fertile situations, under favourable climatic conditions, all burnt land is soon covered with a thick "sole" of grass, in which even were a seedling tree to spring up it would be immediately eaten or trodden down. In new clearings in this class of country a few trees will probably survive for a time in the imperfectly burnt patches, or a light second growth come up amongst the stumps and logs in spots beyond the reach of cattle. But unless permanently protected by some inequality of the ground, as in the case of steep ravines, river-banks, &c., they will gradually disappear as the animals push their way through the rotting timber, and as the fire once more overruns the place, which it is sure to do so long as any considerable portion of the dead stuff remains. This is what may be seen in all its stages on any bush farm, and is taking place on a large scale throughout the districts of Taranaki, Manawatu, parts of the Wellington and Nelson Provinces, and the Akaroa Peninsula, where practically the native bush is a thing of the past, and where in a few years, when the stumps and logs have disappeared, the country will be as clear and open as the Napier or Canterbury Plains.

(2.) In high, mountainous country, especially in regions where the climate for the greater part of the year is cold and wet, the floor of the bush, instead of being covered with an esculent growth of underwood, is chiefly coated with a layer of damp moss; so that there is not much to attract the wandering beasts or to feed a fire even in the driest seasons. In such country the conditions of soil and climate preclude the possibility of settlement, while the trees are generally too small or too difficult of access to be of much economic value from the timber-getter's point of view. This favourable state of things obtains in all high altitudes, but especially in the mountain districts of the south and west; and here it is satisfactory to think that Nature will manage to hold her own, and that the bush will remain in perpetuity to form the appropriate setting of the wild and romantic scenery.

(3.) Scattered throughout the two Islands are numerous portions of country where the contending forces are pretty equally balanced—the cattle and the fire doing a considerable amount of damage, while Nature displays a marvellous power of resistance and recuperation. This class of country occurs principally in hilly and broken districts of moderate elevation, where the soil is of too poor a quality to take grass readily. It is frequently of large extent, and often abounds in scenery of great variety and beauty. A general feature will be at once remarked: that the bush is chiefly confined to the gullies, while the sharp crests and rounded backs of the ranges are covered with fern or scrub tea-tree. The reason of this is obvious. The fires which swept over the dry and exposed surfaces naturally died out when they reached the damp and sheltered hollows. Occasionally extensive areas occur where even the most exposed ranges still retain their virgin mantle. This happens when some natural obstacle—as a river, a deep ravine, or a rocky cliff—has prevented the flames from getting a start on the block. Such wooded areas are not uncommon in localities where the soil is too poor and the surface too broken to make farming a profitable undertaking, or where the bushman has not yet made his appearance. Sooner or later, however, a road or telegraph-line is cut through the thick of the bush, or a settlement laid out in the vicinity, when the balance is upset, and the whole aspect of things rapidly alters; as, once the fires find an entrance, they burn year after year, gradually denuding the most exposed spots, and continuing on until they are once more met by some natural obstacle. A notable instance of this may be seen in the case of the Puhipuhi State Forest, between Whangarei and the Bay of Islands, a few years ago the most extensive kauri bush in the country, and estimated to contain some 400,000,000 ft. of that valuable timber. From mistaken

economy, in order to save a few miles of posts and wire, a telegraph-line 3 chains wide was cut through the very heart of the bush, and at the same time a settlement was laid out on the margin at a place where a heavy kahikatea swamp would for many years have prevented the encroachment of accidental fires. What any bushman would have foreseen was not long in happening. The fires on the telegraph-line were soon joined by those which spread from the settlement. The bush was first gutted and then swept; and at the present time the greater portion of this magnificent forest is destroyed. The same thing is going on on a large scale around the village settlements in the north, in every mining and timber district, and to a greater or lesser degree wherever a new encroachment is made.

4. *Changing Character of the Bush.*

In view of the altered conditions to which the bush has to submit, we shall not be surprised to find that the surviving portions are generally undergoing important changes in character and appearance. We have already noticed the effect of the presence of cattle and pigs in poaching the soil, lacerating the roots, and removing the protective covering of the undergrowth. This, however, is only the beginning, for presently a general and gradual decay sets in, and the more delicate trees—as the tawa, mahoe, kahikatea, and a host of others—die out in rapid succession, leaving the hardier varieties—including most of the pines—standing; and even of these the full-grown specimens generally succumb sooner or later at a rate proportionable to the pressure of the new conditions, and to their own powers of resistance.

5. *Second Growth.*

Nature, however, does her best to restore the damage done to her domain; and on the ground thus opened up, and indeed very often over large areas that have been wholly cleared, a "second growth" of the non-edible varieties soon makes its appearance, and under favourable circumstances frequently attains to very respectable dimensions, though both in size and variety it is far inferior to the original bush. Occasionally this second growth exhibits itself in seedlings from the surviving trees, as in the case of totaras, rimus, miros, beeches, and kahikateas, when a thriving young family may be seen surrounding the old forest patriarchs, or taking their place when they are removed or die from accident or exposure; but more generally it is composed to a large extent of varieties which have hitherto been absent or inconspicuous. The character and appearance of the second growth vary greatly, according to local conditions. As a rule, one or two species

seem to take the lead in particular localities. Thus, near Whangarei are found handsome coppices almost entirely composed of totara; on the broken ground round the Taranaki coast the white-leaved wharangi or pukapuka is chiefly prominent; the makomako, or settlers' "light-wood," springs up over the clearings on the Mount Egmont slope, and on similar light soils elsewhere; on the uplands of the Nelson Province the beech encroaches on the cultivated lands; the terraces between the White Cliffs and the Ngatimaru country, in Taranaki, have a character of their own in the groves of waving korau fern-trees; while on the clay ranges in the vicinity of Mercury Bay the dark cone-shaped rewarewa grows with a regularity suggestive of artificial plantation. The same thing may be seen in the case of the fuchsia, the yellow kowhai, the ake, the towai, the tipau, the houhere, the whau, the ngaio, and a host of other minor forms, each of which seems to seek a place where it can flourish by itself, or where for a time at least it can form the principal feature.

The great exception to this rule is the tea-tree, of which there are two principal varieties—the manuka and the kahikatoa. The tea-tree is the most interesting and important constituent of the "second growth"; it is practically a constant quantity, thriving equally on almost all soils and in nearly every situation—high and low, wet and dry, exposed or sheltered, it is all the same to this hardy and vigorous plant. Distributed, as the late Mr. T. Kirk states,* over all districts from the Three Kings to Stewart Island, and even to the Snares, it is equally at home on the northern gumfields, the pumice plains of the interior, the swamps of the lower Waikato, amid the ocean spray of the storm-swept promontories, and the steam and sulphur vapours of the hot-lakes district. Everywhere adapting itself to circumstances, on barren and exposed situations it flowers and seeds as a plant 2 in. high, while on rich alluvial bottoms it attains the dimensions of a handsome forest tree. The tea-tree is the connecting-link between the old and the new. Though freely burning green in its scrub state, and so helping to spread the fire into the surrounding bush, if it gets a chance it acts as the nursing mother of the new growth. On the clay lands of the north, wherever it manages to escape the fire for a few years, seedlings of the original trees invariably appear under its shelter, among which it is not uncommon to find healthy young kauris, tanekahas, and other forms never seen in the open; and in places where it has survived for a lengthened period the species becomes gradually more numerous, so that it requires an experienced eye to distinguish the new growth from the original bush.

* "Forest Flora of New Zealand," p. 236.

A very perfect example of the second growth may be seen on an old pa (Okuratope) at Waimate North, which is particularly interesting and instructive, as the period can be approximately defined during which it has taken place. The pa is situated on the crest of a clay ridge cropping out through the volcanic country, and is surrounded on three sides by heavy bush, the fourth being bounded by a deep swamp. It was occupied by the great chief Hongi in 1814,* but appears to have been deserted soon after, since when the bush has grown up undisturbed; and at the present time it is covered by a dense growth only distinguishable from the virgin forest by the smaller size of the trees; in fact, were not the attention arrested by the form of the earthworks, which are in almost perfect preservation, the difference might easily pass unnoticed. Within the small area of 2 or 3 acres almost all the trees of the adjacent bush have made their appearance, and it is interesting to see the manner in which the different species have taken advantage of the varying local conditions. On the top, where the crest of the hill has been levelled off to form the upper platform of the pa and the hard clay subsoil is exposed, the ground is occupied by a tall thicket of tea-tree intermingled with a few tanekahas and other trees only found in such situations. Surrounding these a line of towais—some of them as much as 3 ft. 9 in. in circumference—cling to the almost perpendicular face of the ramparts. Numbers of the same tree, together with the rimu and totara, appear on the terraces. Fern-trees have sprung up in the vegetable mould accumulated in the ditch, while descending the outer slope, towards richer soil, the species become more numerous, and the new growth shades off almost imperceptibly into the original bush. The whole place supplies one of Nature's object-lessons, in the study of which, however, we must bear in mind that forty or fifty years ago there were but few cattle running at large, and that consequently the struggle for life was not nearly so intense as it is at present; in fact, were a similar piece of bush now removed in a settled district it would stand a much poorer chance of recovery.

6. *Imported Trees, &c.*

Any speculation on the future of the New Zealand bush would be incomplete without some notice of the introduced trees and shrubs that have gone wild. Of these, the most important are the willows and Australian wattles, the furze and sweet-briar, the common bramble and one of the thorny

* The pa was visited and described by Mr. Nicholas, who accompanied the Rev. S. Marsden to New Zealand in 1814.

hakeas. The willows have mostly originated from trees planted with a view (generally mistaken) of retaining the banks of rivers running through alluvial country. From these broken pieces are carried down by the freshes, and quickly take root, forming continuous groves along the margin, and frequently islands in the bed of the stream. Hundreds of miles of river-banks have been clothed in this way in many parts of the country. So far the varieties have been confined to the tall straight osier and the weeping willow; and, although others will doubtless be introduced from time to time, these will probably hold their ground by reason of their large and vigorous growth. The Australian wattles seem to have been among the first plants imported into the colony. Several species are found about most of the older settlements, where they have flourished and increased as the native bush has died away. The furze, originally used as a hedge plant, and the sweet-briar, probably intended only as an ornamental shrub, have also come to stay, and in many places have taken complete possession of the country, so much so, in fact, as to considerably depreciate the land-value. The common bramble has made an unwelcome appearance in the bush districts north of Auckland, where it threatens to become such a nuisance that the various agricultural societies have already been trying to devise means for its eradication. And in several spots between the Bay of Islands and Whangaroa the hakea is spreading rapidly among the fern and tea-tree, and forming an impenetrable thicket wherever its winged seeds light on a patch of burnt ground. The foreign element has already added a new feature to the forest flora of the country, which will be more and more conspicuous as the present species spread further afield, and as new ones are introduced.

7. *Future Diminution of Fires.*

For a long time to come the fires will overrun the country more or less every dry season, but after a while they will gradually decrease, both in extent and destructiveness.

The area of bush land available for settlement is limited; and after the dead timber has been consumed, and the country reduced to cultivation, there will be nothing to carry the flames over a wide extent. We may therefore confidently hope that in a few years such terrible conflagrations as have lately overspread whole provinces will be things of the past, and that the fires that do occur will be comparatively small and local.

The same thing will happen, though much more slowly, on the large areas of open land now covered with fern or tea-tree. As the cattle and sheep find their way over the run the surface growth is consumed or trodden down to some extent, and grass springs up from the seed carried in their droppings. It

is true that the fern or tea-tree is not long in reasserting itself, but the animals continue their work, and sooner or later the grass must get the mastery; so that the native growth, if it does not disappear altogether, will be broken up into patches, when a fire of large extent will become impossible.

This comparative cessation of fires will have a marked effect on the country. By degrees the dead timber, which now forms such an unsightly fringe to the bush, will decay and disappear, and, instead of furnishing fuel for further destruction, will help to fertilise the ground. The trees which are able to bear the new conditions will take on fresh vigour, and the seedlings, whether within the forest or forming an independent growth, will have an opportunity of coming to maturity.

8. *The Residuum.*

This state of things, however, is still in the far distance, and when it does take place the residuum will be much smaller than is generally supposed. The rate of destruction is greater at the present time than at any former period; and it is probable that for some years to come it will increase rather than diminish. Bush settlement is being pushed on all over the country to meet the wants of the growing population, and the timber industry is keeping pace with an extending market. The kauri and kahikatea forests are being rapidly exhausted, and every available stick of rimu, totara, black-pine, birch, and puriri is being removed from the general bush to supply material for house- and ship-building, for bridges and railway-sleepers, for wharf-piles and telegraph-poles, for mining-props, posts and rails and palings and shingles, for gum-boxes and butter-kegs, and so forth—and, as the favourite timbers grow scarce, recourse will necessarily be had to the now lesser-known varieties. So far any attempt at conservation has been futile, if not actually mischievous, and will doubtless continue so until the community awakens to a sense of its loss, when reform will come too late to be of much use. Arguing, therefore, from present facts and tendencies, we must face the conclusion that, with the exception of the "second growth," together with certain comparatively insignificant remnants scattered through the broken districts from which most of the character will have departed, the permanent residuum of the New Zealand bush will be practically confined to the high mountain-ranges, more especially in the south and west, where the land is generally rugged and precipitous and the rainfall abundant.

In predicting the appearance of the bush of the future it is, of course, impossible to deal in other than very general terms. As at present, it will vary with every accident of soil, climate, and aspect. But, speaking generally, we may expect

to see an infinite gradation between the portions which remain practically in their virgin condition on the mountain heights and sheltered gorges and the outlying fragments in the lower and cultivated districts; and that, in proportion as it is affected by the new conditions, the bush will be more clear and open, the trees fewer in variety, and of a shorter and bushier habit. There will also be an increasing admixture of the foreign element, and less and less of the original undergrowth.

Behaviour of Individual Trees.

As a help towards the solution of the question at issue, I append a few short notes on the behaviour of some of the most important trees under the ordeal to which they have to submit.

The Kauri.—Naturally the kauri first claims our attention. It is painful to think that this noble and beautiful tree is destined within a comparatively few years to become practically a thing of the past. As noticed in my former paper, the floor of the kauri bush is covered with a thick coating of vegetable humus (*pukahu*), which is rendered highly inflammable by a mixture of dead leaves, particles of gum, and scales dropped from the resinous bark; so that, even if the trees are not felled for timber, they run a constant risk of being killed by fire. Under very exceptional circumstances a few single specimens, or small clumps isolated in the mixed bush, may manage to survive in some deep and sheltered gully; and these, together with the "rickers," too small to be worked to advantage, and the seedlings in the "second growth," will soon be all that is left. After the fire has passed two or three times over the site of a kauri bush the land generally settles down to a short growth of tea-tree scrub.

*The Rata.**—The rata, or at least the northern variety, is also to a great extent doomed to disappear, though generally by a different process. Starting in life as an epiphyte among the branches of some lofty tree, the rata sends down its aerial roots, which on reaching the ground thicken and gradually enlace the trunk of its supporter, often squeezing it to death, at the same time putting out great spreading branches above, and eventually becoming the largest and most conspicuous tree in the forest. Robust and vigorous as it appears, however, it cannot long stand the new conditions. First we miss the grand crown of crimson bloom; next we notice the gradual shrinking of the rounded tufts of foliage; and soon the spreading limbs are but a giant cluster of stags' horns,

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* For an excellent account of the rata, *vide* Kirk's "Forest Flora of New Zealand," *s.v.*

lichen-coated, and dropping to decay. The great coil of twining roots are almost superficial, and fail to draw their nourishment from the bare and hoof-trodden ground.

Mountain Rata.—For the mountain rata of the South there is a happier prospect. It is a true tree, better rooted than its northern congener, and with its advantages of climate and situation will probably continue one of the most conspicuous features of the alpine scenery.

Puriri.—The puriri, as Mr. T. Kirk has noted, is the only tree which is able to resist the strangling pressure of the rata, and it is one of the few which, in anything approaching an adult stage, will survive the removal of the surrounding bush. It will stand any amount of hacking and cutting about; and even when partly destroyed by fire—so long as the bark is not burned round the root—it will renew its youth by a fresh growth from the trunk and lower branches. Unfortunately, the species is of limited distribution, being confined to the upper half of the northern Island; and, as the timber is in great request for railway sleepers, fencing-posts, &c., all the best specimens are rapidly disappearing. Moreover, there is not much chance of its renewal, except in places inaccessible to stock, as the seedlings are quickly eaten off. Still, the puriri is a long-lived tree, and probably existing specimens will survive for an indefinite period. An example of its vitality may be seen in the old mission settlement of Waimate, where several beautiful clumps have held their ground against the cattle in enclosed paddocks for at least fifty years. Even after death the puriri is a noble object, as, bleached to a snowy whiteness, it stands with all its branches perfect long after every vestige of the surrounding bush has disappeared, both above and below ground, apparently insensible to decay.

Kahikatea.—The kahikatea, or white-pine, is distributed over the greater part of New Zealand, and is found in greatest abundance in low and swampy situations, where it frequently forms continuous forests of large extent. Specimens of a harder variety are common in the mixed bush on higher ground. Generally easy of access, and affording a useful timber, it is being largely removed for mill purposes. The kahikatea is a delicate tree, and does not long survive under altered circumstances; in fact, during the last few years immense bushes have disappeared with marvellous rapidity, their sites being now occupied by cabbage-tree, flax, and raupo swamp, according to the comparative wetness of the situation. In the drier portions the ground is often covered with a close crop of seedlings, many of which attain a considerable height. It is doubtful, however, if they will equal the parent growth.

Other Pines.—Of the other so-called pines the totara and rimu—both noble trees and of wide distribution—are the most important. They are, however, much sought after for the excellence of their timber; and it is only a question of time when all the best specimens will be removed in all accessible situations. Fortunately, the seedlings are cattle-resistant, and perfectly hardy; and the totara and rimu, together with the matai, tanekaha, miro, &c., will form an important element of the bush of the future.

Beeches.—The beeches, of which there are several varieties, are chiefly confined to the South Island, where they frequently form continuous bushes of large extent. The timber is used for all purposes, and the best portions have been already cut out. Mr. Kirk has pointed out a property of the beech-forest which, with the exception of the tea-tree, is quite unique in the New Zealand bush—viz., its power of renewing itself from seed, all that is required for its perfect restoration being the exclusion of cattle (*vide* "Forest Flora of New Zealand": Art. *Fagus*).

Tawa.—The tawa, though unimportant as a timber tree, deserves mention on account of its large size, wide distribution, and handsome appearance. It is common to all parts of the North Island, and formed a few years ago one of the most attractive features of the extensive forests of Taranaki, Hawke's Bay, and Wellington, now mostly destroyed by fire. It is a tall, graceful tree, with a clean trunk and light willow-like foliage. The timber until lately was considered to be of little value except for firewood, on account of its perishable nature, but of late a use has been found for it in the manufacture of butter-cases, for which it is excellently adapted. The tawa is, unfortunately, one of the first trees to disappear, as the roots stand out above the surface, and are covered with the very thinnest of bark. In many districts where the bush is otherwise in fairly good preservation it has almost entirely perished.

Towai.—The towai is a large, handsome tree, chiefly valued for the tanning properties of its bark. It is distributed all over the colony, and has the distinction of being the only tree above the size of a mere bush which grows in the open fern land, where it quickly springs up from the root after a fire. It is found in great abundance on steep rocky river-banks, and flourishes on high and exposed situations. Although its roots are very superficial, the towai is fairly cattle-resistant, and is destined to figure largely in the bush of the future.

Titoki.—Though comparatively inferior in point of size, the titoki has a strong claim on our attention from its extreme hardiness under all conditions. It is never touched by cattle, and is often found green and flourishing in the midst of the

dying bush, as well as in the "second growth." It is a remarkably handsome tree, with a dark glossy ash-like leaf and bright scarlet berry, and affords an excellent timber for all purposes where toughness and elasticity are required.

Pittosporums.—The *Pittosporums* form a large class, and are distributed more or less all over the country. They are of no great size, and of little account as timber trees; but, being extremely hardy and perfectly cattle-resistant, their graceful outline and beautiful foliage add greatly to the appearance of the forest. Like the titoki, they are often found in increasing quantities as the old bush dies away, and it is not uncommon to meet with healthy plants springing up in shrubberies and garden-ground from seeds carried by the birds.

Fern-trees.—Much of the characteristic beauty of the New Zealand bush is owing to the presence of the fern-trees scattered through the undergrowth. Although botanists are able to distinguish a larger number, they are generally divided by bushmen and ordinary observers into three species—viz., the tall waving korau or mamaku, the more robust ponga, and the short thickly growing wheki. The two latter are not much molested by cattle, unless the place is very heavily stocked, but the succulent fronds of the korau are immediately eaten whenever within reach. As, however, this species chiefly affects low and damp situations, it is frequently found in deep, narrow watercourses, where it forms beautiful palm-like groves secure from the attacks of the enemy.

III.—GEOLOGY.

Art. XL.—*Corrections in the Names of Some New Zealand Rocks.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 3rd August, 1698.*]

In September, 1897, the Rev. Richard Baron, who is well known from his researches on the rocks of Madagascar, while on a visit to New Zealand, examined the greater part of the collection of rocks in the Museum on which my paper on "The Eruptive Rocks of New Zealand,"* was founded. He agreed with most of my descriptions, but made some criticisms and corrections, which he has kindly allowed me to publish. To these I add a few remarks and alterations which I wish to make myself.

Corrections in Paper on "The Eruptive Rocks of New Zealand."

(Page 109.)

Foot-note.—For "colloid glass" read "cooled glass."

(Page 112.)

Granite from Cape Foulwind.—The alternating layers of orthoclase and microline form what is commonly known as "chesterlite."

Granite from Port William.—The occurrence of microline is doubtful (*Baron*).

Granite from Denniston.—Contains sphene (*Baron*).

(Page 114.)

For "elvanite" substitute "eurite," as the term "elvanite" seems to have dropped out of use.

(Page 115.)

Rhyolite from Lyttelton.—This has been called a tridymite-trachyte by Mr. P. Marshall, in Trans. N.Z. Inst., vol. xxvi.,

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* Pro. Royal Soc. N. S. Wales, vol. xxiii., p. 102, 1889.

p. 368, on the supposition that the large percentage of silica is due to the secondary deposition of tridymite, which appears to be the case.

(Page 120.)

Palla.—For a reference to Sir J. von Haast's use of this term, see Trans. N.Z. Inst., vol. iv., p. 85. It is there said to occur also in Transylvania.

(Page 122.)

Hornblende Trachyte from the Sugar Loaves, Taranaki.—Plagioclase is more abundant than sanidine (*Baron*). An analysis of this rock has been published in the Laboratory Report, No. 25, for 1889–90, p. 59, which shows that it contains only 53·43 per cent. of silica. It should therefore be called a hornblende andesite.

(Page 128.)

Enstatite Diorite from Bluff Hill.—This is a norite, or enstatite-gabbro, the hornblende being secondary (*Baron*).

(Page 129.)

For "porphyrite" substitute "aphanite," as the term "porphyrite" is now generally used for an altered andesite.

(Page 130.)

Augite Porphyrite from Enfield.—These rocks are basalts (*Baron*).

(Page 142.)

Olivine Andesite from Banks Peninsula, No. 2.—This rock has been described in detail by Mr. R. Speight in the Trans. N.Z. Inst., vol. xxv., p. 367. The specific gravity is only 2·61.

(Page 150.)

Basalt Group.—Under this head eliminate the words "and plagioclase."

(Page 151.)

Basalt from Banks Peninsula, No. 1.—This rock comes from what is known as the Halswell Quarry.

Corrections in Other Papers.

"*Transactions of the New Zealand Institute,*" *vol. xxiii., p. 354.*

The hornblende diorites are epidiorites, as the hornblende is secondary; originally they were enstatite-gabbros. The hornblende porphyrite should be called a dolerite.

"*Transactions of the New Zealand Institute,*" *vol. xxiv., p. 363.*

The hornblende diorites are, probably, epidiorites. I have a specimen of a boulder from near Cuttle Cove, Preservation Inlet, which Mr. Baron is confident is an epidiorite.

ART. XLI.—*On a Supposed Rib of the Kumi, or Ngarara.*

By Captain F. W. HUTTON, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 5th October, 1898.*]

AMONG the bones found in the Earnscleugh Cave, in Central Otago, when it was cleared out for the Otago Museum Committee in 1874, was the ramus of a lower jaw of a pleurodont lizard,* which may, provisionally, be supposed to belong to the extinct kumi, or ngarara, of the Maoris.† This bone, unfortunately, was not described, but, so far as I can remember, it was about the size of that of a tuatara. The dentition, however, was decidedly pleurodont, and the teeth, I think, were stronger than those of the *Iguanidæ.*

In a collection in the Canterbury Museum from the same cave—received in exchange from the Otago Museum early in 1892—I find what appears to be a small vertebral rib, belonging to the left side, and which may possibly have belonged to the same animal. It may be the last cervical of a reptile, although it seems to be too robust and too flattened for the rib of a lizard. It more nearly resembles the first thoracic rib of a mammal, but it does not appear to have been attached to a costal cartilage, and the shape of the head and tuberosity is different. It is, indeed, unlike anything known to me.

It is much curved, robust, flattened distally, and with the inner edge of the flattened portion denticulate, as can be seen in the figure. There are seven denticulations, six of which are very distinct. There is a small but well-marked pointed tuberosity. The apex of the shaft is oblique to the axis, sharp, not flattened for the attachment of a cartilage or sternal rib. The length, measured along the curve, is about 14 mm.; and the breadth at the commencement of the denticulations is 2·75 mm.

* Trans. N.Z. Inst., vol. vii., p. 139.
† Stack, Trans. N.Z. Inst., vol. vii., p. 295.

Art. XLII.—*On the Footprint of a Kiwi-like Bird from Manaroa.*

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate XLV.

The specimen which I exhibit was found by H. Wynn Williams, Esq., in a creek near his house at Manaroa, Pelorus Sound, and was by him presented to the Canterbury Museum last month. The rock is a pale-grey, hard, argillaceous sandstone, without any appreciable amount of carbonate of lime. It is jointed, and with iron-oxide coating the sides of the joints. It reminds me of the sandstones of the Waitemata series at Auckland, and is, apparently, of Miocene or Eocene age.

The impression is the left foot of a bird, and is sharply marked, but the surface of the stone has been somewhat abraded, and the impression of the distal portion of the inner toe has almost disappeared. There is a mark behind the foot which looks like the impression of the claw of a hind toe, but I do not think that it is so. If such were the case, the impression must have been made by a straight claw, about 1 in. long, lying flat on the surface, while the rest of the toe must have been elevated, for there is no impression joining the supposed claw to the foot. The distance thus unmarked is about ½ in., and is too short for the hind toe of *Notornis*, or an allied form; while in birds with the hind toe elevated and short the claw is short and curved, and would only make a circular impression on the ground. Also, this impression in the stone is of a different character to the others, and has, I think, been made later. There is no appearance of any interdigital membrane.

The following are the dimensions: Length from heel to end of the claw of the middle toe, 98 mm.; to end of inner toe, 90 mm.; to end of outer toe, 93 mm.; spread from claw of outer to that of inner toe, 112 mm.; breadth of the impression of the middle toe, 13 mm.; depth of the impression at the heel, 8 mm.

The impression is much smaller and more slender than the footprints that any known moa would have made, and the base of the foot is too broad for any species of *Ocydromus* or allied form; but, so far as size and shape goes, it might have been made by a large specimen of *Apteryx australis*.

The figure (on Plate XLV.) is from a photograph by Mr. W. Sparkes, and is rather less than the natural size.

Art. XLIII.—*Notes on a West Coast Dolerite.*

By W. A. MacLeod, B.Sc.

[*Read before the Auckland Institute, 15th August, 1898.*]

Plate XLVI.

This is a rock forming a large dyke running parallel to the strike of the lodes now being prospected by the Anglo-Continental Syndicate on Victoria Range, Westland.

Microscopically it is a dense, dark-coloured, basaltic-looking rock, and from its appearance might be any one of several of the more basic rocks. The fracture is on the whole even, though slightly inclined to be rough and hackley. Specific gravity, 2·88. The following is a chemical analysis :—

SiO_2	54·23
Al_2O_3	15·22
Fe_2O_3	2·84
FeO	9·47
CaO	8·56
MgO	2·93
K_2O	0·92
Na_2O	5·80
Ignition loss	1·00
	100·97

The percentage of SiO_2 in the above is slightly high, and on the other hand that of the MgO is a little low, probably due to the rather small proportion of augite present.

Under the microscope the constituent minerals are augite and plagioclase feldspar, a little base of a micro-crystalline nature being present, but, as the rock is almost holocrystalline in nature, I have termed it a dolerite, and not a basalt.

The augites in ordinary light are colourless, or of a faint violet-brown tint, in which latter case pleochroism is just visible. The crystalline form is generally rudely developed, though sometimes well shown. The prismatic cleavage is only moderately developed, and many of the crystals show an irregularly fractured surface. In size they vary from 0·05 mm. to 1 mm., though larger crystals may be found in other sections. The polarisation colours are brilliant, and resemble those of olivine. The angle of extinction $C : c = 41°$ (approximately).

The feldspars occur abundantly in laths and needles, varying in size from about 0·05 mm. to 0·5 mm. By ordinary light

they appear as colourless rods or narrow plates, generally twinned. The extinction angles, varying from 20° to 35°, indicate that the feldspars are chiefly labradorite, with perhaps a little anorthite.

The chief accessory minerals are magnetite (probably titaniferous), occurring probably as a decomposition product of the augites, and carbonate of lime in small thread-like veins. A little apatite is present in the augites, and gas-pores and negative crystals occur in the feldspars.

The various constituents follow the normal order of consolidation, and the almost holocrystalline nature of the rock points to its having consolidated slowly and under pressure, and to its probably being a dyke rock, though perhaps at its original surface (now denuded away) it may gradually have merged into a basalt.

Appended (Plate XLVI.) are two diagrammatic water-colour drawings—No. 1, under ordinary light; No. 2, under crossed nicols. *a* = augites; *f* = feldspars.

Art. XLIV.—*Notes on a Hypersthene Andesite from White Island.*

[*Read before the Auckland Institute, 15th August, 1898.*]

By W. A. MacLeod, B.Sc.

Plate XLVII.

This is a rock of a dark-grey colour, irregular fracture, and specific gravity 2·65. In hand specimens the feldspars are conspicuous, reflecting the light from their smooth faces, whilst the hypersthenes only appear as dark oblong patches. The following is a chemical analysis of this rock:—

SiO_2	64·49
Al_2O_3	14·26
Fe_2O_3	3·91
FeO	3·28
CaO	3·67
MgO	1·25
K_2O	0·40
Na_2O	6·60
Ignition loss	1·22
	99·08

The SiO_2 in the above is some 4 to 7 per cent. higher than

in foreign andesites, whilst on the other hand the alumina, iron, lime, and magnesia are proportionally lower, suggesting that either secondary silica has been introduced into the base or that the rock as a whole is slightly decomposed; more likely the latter, as I find it very hard in this district to obtain perfectly fresh specimens of andesitic rocks.

Microscopic Examination.—Hypersthene and feldspar form the phenocrysts (no augite being visible in the sections I determined), and are set in a base dusted with grains of magnetite.

The hypersthenes occur in small crystals up to about 1 mm. in length, generally in isolated well-defined crystals, though sometimes in bunches. They are fractured at right angles to the vertical axis, and exhibit also, in some sections, branching irregular cracks. The brachypinacoidal cleavage is noticeable, and in cross-sections sometimes the prismatic. In ordinary light they appear light-brown. The pleochroism is strong. a = red-brown; b = red-yellow; c = pale sea-green. The polarisation colours are fairly brilliant, and the extinction straight.

The feldspars generally occur in plates, accompanied by the lath-shaped type, and vary in size up to about 3 mm. or 4 mm., being much larger than the hypersthenes. By ordinary light they are colourless. but by polarised light they often show polysynthetic twinning, and the extinction angles prove them to be probably andesine, with a little oligoclase.

The base is largely developed in proportion to the phenocrysts. By ordinary light it is of a dirty-brown colour (in thin sections a light-drab), and is seen to be dusted with fine grains of magnetite, and by polarised light the base is seen to be micro-crystalline and feldspathic.

The chief accessory mineral is magnetite, occurring principally in the base, and it is not likely to be a decomposition product of hypersthene phenocrysts, which are fairly fresh and undecomposed. Vitreous inclusions, with gas-pores and negative crystals, occur in the feldspars. Traces of kaolin occur as a decomposition product of these crystals.

The various constituents follow the normal order of consolidation, and the rock is a good sample of a hypersthene andesite, the hypersthenes especially being in beautiful crystals.

Appended (Plate XLVII.) are two diagrammatic water-colour drawings—No. 1, with polariser only; No. 2, with crossed nicols. h = hypersthene; f = feldspar.

Art. XLV.—*Notes on a Hornblende Trachyte from Tawhetarangi.*

By W. A. MacLeod, B.Sc.

[*Read before the Auckland Institute, 10th October, 1898.*]

Plate XLVIII.

A sample of this rock was left me by Mr. S. A. R. Mair, surveyor; and, on account of its peculiar nature and appearance, I have, as a slight addition to the petrography of the Hauraki Peninsula, written the following outline concerning it.

My specimens were obtained at Tawhetarangi, or Amoteo Bay, about ten miles north of Coromandel. Nearly two miles inland, at an elevation of some 650 ft., Mr. Mair discovered some boulders in the hillside *débris* along with others of a coaly substance, and from appearances, and on account of their being found near the top of the ridge, they could not have travelled far, though he could obtain no trace of them *in situ*, the country being covered with dense bush.

A somewhat similar, though darker-coloured, rock forms a dyke in Castle Rock, and quite lately Mr. J. M. Maclaren, Director of the Coromandel School of Mines, discovered a like rock forming a dyke in Moehau.

The microscopic characteristics are very striking, especially the colour and arrangement of the constituent minerals. The feldspathic portion is almost pure white, and crystalline to semi-vitreous. In it are set the porphyritic hornblendes, some of which are over ½ in. in length, whilst here and there star-shaped twins of the same mineral stand out conspicuously. At first sight the rock might be taken for one of the granitic to syenitic type, but on closer investigation, by aid of the microscope and chemical analysis, it is seen to be a trachyte. Its fracture is uneven and massive, and its specific gravity, which I determined both by the ordinary method of weighing in air and water and also by the specific-gravity bottle, is abnormally low, being 2·52 to 2·53. This is probably due partly to infiltrated chalcedonic quartz and partly to the numerous gas-pores contained in the feldspars. Chemical analysis shows the following composition:—

SiO_2	70·34	MgO... ...	1·74
Al_2O_3 ...	10·13	Na_2O ...	5·01
Fe_2O_3 ...	0·56	K_2O	2·06
FeO	4·02	Ignition loss ...	2·14
CaO	5·18		101·18

In this analysis the high percentage of SiO_2, which is a noted feature in many of our rocks, is most likely due to infiltrated silica, patches of which are clearly discernible under the microscope.

Under the microscope the constituent minerals are seen to be feldspars and hornblendes set in a base, and following the natural order of consolidation. The hornblendes vary greatly in size, some being quite microscopic, whilst others are over $\frac{1}{2}$ in. in length. T-shaped twins are visible in some sections. Their colour by ordinary light is brown, with a faint tinge of green, and on inserting the polariser the pleochroism is very marked, and is as follows:—

γ = Dense green-brown.
β = Yellow-brown.
α = Honey-yellow.

The cleavage is well defined, especially the prismatic, which is well shown both in longitudinal and cross sections. The polarisation colours vary from yellow-brown to dark green-brown, and the extinction angle C : c varies from about 14° to 16°. The hornblendes show a well-marked dark border-line, due to corrosion in the molten magma previous to consolidation.

The feldspars vary in size from quite microscopic plates and laths up to 5 mm. to 6 mm. long. By ordinary light they appear as colourless plates, with here and there a few colourless laths. Under polarised light they appear much twinned, and exhibit zonary banding, and the extinction angles varying from about 4° to 10° point to their being oligoclase, though the analysis showing some 2 per cent. K_2O would point to the probability of some of the feldspar being anorthoclase.

The chief accessory minerals are magnetite, occurring in the hornblendes, and infiltrations of chalcedonic silica in cavities in the base. Negative crystals and gas inclusions are very numerous in the feldspars, whilst inclusions of the latter mineral are found in the large hornblendes.

The base consists chiefly of a crypto-crystalline aggregate of feldspathic matter, with here and there small granules of feldspar scattered through it.

Appended (Plate XLVIII.) are two water-colour sketches of sections of this rock—No. 1, under ordinary light; No. 2, under crossed nicols. *i* = inclusions of silica; *f* = feldspars; *h* = hornblendes.

Art. XLVI.—*On Occurrences of Gold in the Coromandel District.*

By J. M. Maclaren, B.Sc.

[*Read before the Auckland Institute, 20th June, 1898.*]

Plates XLIX. and L.

Native gold generally occurs massive or in thin plates or scales. It is sometimes, but rarely, found crystallized as octahedra or rhombic dodecahedra of the isometric system. Still more rarely do cube forms occur. The occurrence to be described possesses all three crystal forms, and was obtained from a "vugh" or cavity in a reef of clear crystalline quartz, adhering very loosely to the quartz crystals, and raised in fanciful shapes above them, resembling, indeed, nothing so much as a butterfly with outspread wings. So marked is the resemblance that even before it had been removed from the reef, and while it was still *in situ*, the finders had named it "The Golden Butterfly" (see Plate XLIX.).

The body of the "butterfly" is composed of irregularly shaped isometric crystals, and the "wings," in the main, of five flat lamellar rhombic dodecahedra, so irregularly developed as to present, at first sight, the appearance of flattened monoclinic prisms. Of these five plates, three are on one side and two on the other, and the three largest present a marked similarity in crystalline form, being formed essentially of a single rhombic dodecahedron divided at one end to form two separate similar crystals (Plate L., figs. 2 and 3). On one side only of the medial line are cube crystals developed, this side being probably the lower when the crystals were in their natural position. All the plates, or "wings," were attached very loosely to the main body by an irregular subcrystalline projection, as shown in figs. 2 and 3. No gold was found near the specimen.

Taking one plate as typical of the rest, and considering one side of it first (fig. 2), it will be found that the basis of the form is a single rhombic dodecahedron divided at one end into two distinct smaller rhombic dodecahedra (*i*, *i*). These, as shown by the darker hatching, are surmounted by two more rhombic dodecahedral planes (1, 1), and these again by a succession of at least seven octahedral planes, denoted on the gold crystal by fine lines. These faces have plane angles of 60°, and interfacial angles of 110° (? 109° 28′ 16″), as nearly as I could determine them with the somewhat crude

goniometer at my disposal. There is no appearance of any twinning on an octahedral plane.

The reverse side (fig. 3) presents the same dodecahedral outline. Here, however, two dodecahedral planes form the basis, surmounted by octahedral planes (1, 1), and these again by a final dodecahedral plane (*i*). On this side, and with an edge parallel to the edge of an octahedron, is a cube corner (H, fig. 3). This cube has the apex bevelled inwards, forming a depression, as shown in fig. 6. In none of the cubes or octahedra that I have examined have salient edges been discovered. The cube faces have plane and interfacial angles of about 90°.

An apparently similar form has been described by a previous observer* as a pseudomorph after botryogen or red iron vitriol, but, as I have been unable to detect botryogen in the reef, and as pyrites is also far from common, it is hardly likely that the gold, in this particular case at any rate, has crystallized as a pseudomorph, more especially as the angles (fig. 4) approximate much more closely to the 120° of the rhombic dodecahedron than to the 117° 24′ of botryogen, and therefore the most logical conclusion seems to me that it has crystallized in its natural system. However, as I have mentioned, unequal development of the faces will produce a strongly marked monoclinic appearance.

The specific gravity of the "gold" is about 17·6, and the fineness is therefore 0·8842, assuming the other constituent to be silver, which from the colour is probably the case.

Gold in Calcite.

Several instances of this rare occurrence have lately been brought under my notice. The following appears to be a typical mode: The calcite appears as an incrustation on the walls of a quartz reef, and the deposition of gold and of calcite appears to have been contemporaneous. The calcite is in the form of Iceland spar or double-refracting spar occurring in clear rhombohedra. The gold is scattered in thin scales and plates throughout the Iceland spar, with, apparently, no relation to the cleavage planes of the spar, for the scales cross these planes at all angles. The gold presents no crystalline faces, and from the colour appears to be much poorer in quality than that from the adjoining quartz reefs.

The very limited leisure time at my disposal has hitherto prevented me from devoting my attention to the mode of deposition of the gold in the calcite, and I must plead the same excuse for the general brevity of these notes.

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* Trans. N.Z. Inst., vol. xiv., pp. 457, 458.

Art. XLVII.—*On the Geology of Te Moehau.*

By J. M. Maclaren, B.Sc.

[*Read before the Auckland Institute, 10th October, 1893.*]

Te Moehau is the highest point in the northern portion of the Cape Colville Peninsula. From the cape the range rises somewhat abruptly, culminating in two castellated peaks 2,900 ft. above sea-level. To the south, however, a gentle fall terminates in a low saddle, about 800 ft. high, between Cabbage Bay and Waikawau. Though thus apparently an isolated mountain, it is certainly a part of the main axial elevation of the Hauraki Peninsula, an elevation that has its northern termination in the Great Barrier Island.

From the superstitious dread of the higher parts of the mountain entertained by the natives, and from there being no inducement for settlers and others to ascend it, the summit has been but rarely visited. The Maoris, who were formerly very numerous in this district, averred that on the higher slopes of the mountain there exists a race of men, small in stature and ruddy in appearance. These men they called "Turehu," and on foggy days—which, indeed, are neither few nor far between on Moehau—their voices and those of women and children may be heard piercing the misty silence. The origin of this legend, unique in Maori folk-lore so far as I know, at any rate in its present setting, is unknown, and the most feasible explanation that has so far been advanced to account for it is that the legend arises out of the enmity that ever exists between coastal and inland tribes. My own theory, however, traces the legend to a much more insignificant source. Remembering that the Coromandel district is practically the sole habitat of the rare little New Zealand frog (*Liopelma hochstetteri*), and Moehau its only certain place of abode, I think that we have here the basis of the legend. It is extremely improbable that this animal was more common during the occupation of the peninsula by the Maoris than it now is, and the rarity of the animal, its similarity to a lizard —always an object of dread to the Maori—its singular mode of progression, its colour, and finally its many attitudes, so grotesquely human, must have appealed strongly to the Maori mind, already prone, as we know from their carvings, to a belief in distorted humanity.

The first ascent of Te Moehau was made by Mr. James Adams, B.A., of the Thames High School, in January, 1890,

and since then the summit has been visited some half-dozen times only, and then mainly by surveyors using the "trig." during the late "boom."

Mr. Adams ascended from Waiaro, on the western shore, but the easier route, and the one that is generally used, is that from Port Charles. From Port Charles the track crosses to Sandy Bay, and thence up the Okahutahi Creek, which has its source in Moehau. The andesitic lavas and breccias, seen on the coast, continue for about a mile up the creek, when slaty shales and mudstones appear in the bed of the stream, though high up on the spurs on either side the overlying igneous rock, which has resisted the denuding efforts of nature, still appears. Taking one of the slate spurs to the left, after a somewhat arduous climb of nearly 2,000 ft. the main ridge is reached, along which a track, worn into mud by the wild cattle that abound on Moehau, runs north for about three miles to the foot of the peak. The whole of this ridge, averaging about 2,100 ft. above sea-level, is composed of decomposing yellow slaty shales and mudstones, showing occasionally sheddings of quartz. At a height of about 2,400 ft. the vegetation becomes stunted and covered with lichen, clear indications of the average climatic conditions. Here also was found the first evidence of the igneous nature of the summit, in the shape of boulders of much-decomposed andesite lying in the water-holes of a small creek. The ascent now becomes very sharp, and with the rapid rise the trees gradually diminish in height until they are only breast-high. Rimu (*Dacrydium cupressinum*) are seen 4 ft. high with trunks 1 ft. in diameter. Higher still the trees disappear, and the last 100 ft. of ascent is accomplished over a grassy sward. The summit is steeply precipitous with cliffs 50 ft.–100 ft. in height on three sides.

The view from the top is, to say the least, magnificent. Under-foot, apparently, lie the green flats of Port Charles, Waiaro, and Cabbage Bay, constituting a pleasing relief to the prevailing sombre hues of the densely clad bush ranges. On the one hand lie the glancing waters of the Hauraki Gulf, studded with island gems; over and beyond are the Waitakerei Ranges, fading away to a blue haze. On the other hand, and in front, the horizon is unbroken, save for the rugged outlines of the Great Barrier. To the south the eye travels over valley after valley, range after range, apparently interminable—mute monuments of nature's sculpture.

Considerable variation of opinion exists between previous writers on the subject of the geology of Te Moehau. Mr. McKay, the Government Geologist, from information supplied to him, considers that the peak is formed by one large dyke of andesite, and that the mass of the mountain consists of

slaty shales. So far as I could ascertain, however, the igneous rocks on the summit do not appear to be intrusive, and in this view I am confirmed by the fact that the section of the rock under the microscope conclusively proves that it is not, and never has been, holocrystalline. In other respects my observations tend to confirm Mr. McKay's views, more especially as to the height to which the slates reach. Mr. Park, on the other hand, shows * a section across Te Moehau in which he represents the mass of the mountain to consist of solid andesites, the andesites reaching nearly to sea-level. My examination, so far as it went, of the spurs and ridges on the slopes of the mountain does not, however, tend to support this view.†

From stratigraphical and petrological considerations, therefore, I am disposed to consider these volcanic rocks as forming part of an old andesitic flow which formerly extended far to the east, and which had its origin in the dykes that are now found on the eastern slopes. One of these dykes is 50 ft. in width, approximately vertical, and strikes north and south, parallel with the main axis of elevation of the peninsula. The microscopical examination, as will be seen from the detailed description of the sections, does not discourage this view. The feldspars are identical, and the augite of the andesite is represented in the dyke rock by its plutonic congener, hornblende. In both, the feldspars are highly corroded, and, in fact, everything points to a common origin, the difference in texture, in size, and nature of the ferro-magnesian silicate being clearly due to different conditions of cooling.

Appended are detailed descriptions of the rocks mentioned above, together with notes on a hornblende andesite which overlies the slate spur from Moehau on the low saddle between Cabbage Bay and Waikawau.

Summit of Moehau.

Augite Andesite.—A compact, dark, greenish-grey, non-porphyritic rock. Specific gravity, 2·63. Base abundant and much decomposed. Microlites and laths of feldspar up to 0·05 mm. in length. Feldspars much kaolinized, showing polysynthetic twinning. From their extinction angle (about 30°) they must be grouped with labradorite. Phenocrysts much corroded. Pyroxenes monoclinic, faintly zoned, ranging up to 0·8 mm. in length. Purplish and very slightly pleo-

* "Geology and Veins of the Hauraki Peninsula"; James Park, F.G.S.

† Mr. Park has since informed me that I am in error in supposing that his section as shown is across Te Moehau, it being in reality a section six miles to the north of the mountain. This at once explains the apparent discrepancy.

chroic. Chlorite and magnetite abundant. Chalcedony, showing a black spherulitic cross under crossed nicols, appears along planes of fracture.

Dyke Rock from Eastern Slope of Mountain.

Hornblende Porphyrite.—A coarse-grained porphyritic grey rock with large black crystals of hornblende. Under the microscope the base is seen to be completely holocrystalline. It is abundant, and is formed of feldspar grains, laths, and plates up to 0·02 mm. in length. Feldspars are porphyritic, and range from 3 mm. long by 2 mm. broad to 7 mm. long. They show marked polysynthetic twinning both on the albite and pericline types, the latter crossing the former at right angles. Phenocrysts of feldspar idiomorphic and zoned. From their extinction angle of about 30° they must be placed in the labradorite group. Hornblende is highly porphyritic, as may be seen from hand specimens, ranging up to 12 mm. ($\frac{1}{2}$ in.) long and 4 mm. ($\frac{1}{8}$ in.) broad. They are strongly pleochroic, and show alteration to chlorite. Ophitic plates are not uncommon. Magnetite abundant. The amphiboles and feldspars, from their corroded outlines, evidently crystallized long before the base, or at great depths. Specific gravity, 2·71. Considering, then, the three main features of the rock—viz., its holocrystalline base, its basic plagioclase feldspars, and its porphyritic ferro-magnesian silicate—the rock must be classed as a "hornblende porphyrite." I use the term "porphyrite" very reluctantly, as the use of this term is one of the moot points in the nomenclature of the igneous rocks. Continental petrologists include under the name "porphyrite" the "older" andesites, while some British authors apply the name to andesites altered by atmospheric action, and others again use it in the sense in which I have used it above.

Saddle between Waikawau and Cabbage Bay.

Hornblende Andesite.—A compact greenish-black rock showing no porphyritic minerals. Section: Ground-mass abundant, microlitic, chiefly feldspar plates ranging up to 0·2 mm. in length. Porphyritic minerals are hornblende and feldspar. The amphiboles reach 2 mm. in length, and show remarkable multiple twinning, a feature very rare indeed in hornblende. In one crystal alone there are as many as thirty lamellæ present. Phenocrysts slightly decomposed, showing resorption border and alteration to magnetite along cleavage-planes. Feldspars reach 5 mm. in length, showing polysynthetic twinning both on the albite and pericline types. Zonal bands strongly marked. Phenocrysts much corroded. One section of the rock contains an included fragment of greywacke. This Waikawau rock differs from that from the

summit of Moehau only in the ferro-magnesian silicate, the base, feldspars, &c., being precisely similar.

In conclusion, I may be permitted to state that the above does not by any means constitute an exhaustive paper on my subject. From its inaccessibility, and its densely wooded spurs and ravines, years must necessarily elapse before finality can be reached in that respect.

Art. XLVIII.—*Some Notes on the Volcanoes of the Taupo District.*

By Benedict Friedlaender, Ph.D., of Berlin.

Communicated by T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 20th June, 1898.*]

I.—Tongariro.

Tongariro is not a single mountain, but a highly complicated volcanic system. Models of it which I saw in the colony made it appear that Tongariro was one truncated cone, with the Blue Lake on its top, but obviously models of that nature must have been shaped by persons who never saw Tongariro from an elevated point—either from one of its tops or from Ngauruhoe.*

In the Survey Report of 1891, however, there was published a map of the summit of Tongariro which is practically correct. Unfortunately, I only obtained this plan after having visited Tongariro, and therefore was unable to compare it with nature on the spot. As far as my memory, my photographs, and my notes go the map is essentially exact. But I cannot recollect that part called the "West Crater"—viz., a crater adjoining the North Crater (that is, the crater above Ketetahi), towards the south-west. There may be different reasons for my not recollecting it, and I do not intend to question its existence. I would not have even mentioned it had I not found that this West Crater is wanting not only in my memory, but also in Professor Thomas's sketch-map, published in the Transactions, vol. xxi. (1888), page 348.

* The only model with which I am acquainted in the colony is one that I myself made. The original is in the Colonial Museum at Wellington, and faithfully represents Ngauruhoe as a cone, and Tongariro in its proper multiplex volcanic form with the Blue Lake on its top. The volcanic range so well described by the learned author presents no great difficulties to the tourist, and frequent photographs have made it familiar to the general public.—J. H., Ed.

The depression of the West Crater, perhaps, is only a slight one, and was not counted as a crater proper by Professor Thomas and myself. The region in question must be visible from the highest point of Tongariro (about south-south-west from the North Crater) which I have visited; but I repeat that I cannot fully rely on my memory, on account of the astonishing intricacy of the Tongariro system.

The shape of the system, roughly, may be compared to a huge horse-shoe, the axis of which is coincident with that of the volcanic zone. Its hollow is formed by the South Crater of the survey plan—a vast somewhat elongated basin, surrounded on all sides, except south-west, by steep ridges, the highest point of which is the summit proper of Tongariro. These ridges decrease rapidly in height towards the south-west, and the south-eastern side only reaches the foot of the cone of Ngauruhoe. The view from the trig. station, over the precipitous ridges, down into the sandy velvet-like bottom far below, and beyond the magnificent cone of Ngauruhoe, is extremely picturesque. The northern parts of the horse-shoe are much broader, and contain a considerable number of craters, which together form a rather extensive tableland. The most prominent of these craters are the North Crater (already mentioned) and the Blue Lake Crater (further east).

The map above mentioned shows that the eastern parts of Tongariro are rent open by deep and rather steep valleys, and that on the northern slope there are two active places—viz., the fumaroles and hot springs of Ketetahi on the slope of the North Crater, and Te Mari on the slope of the Blue Lake Crater. Te Mari is a small cinder-cone; and a short distance below it there is another crater, which, according to the map, contains a lake; but I have not seen this lake, as I did not venture too close to the rim of the crater, nor to Te Mari either, on account of the somewhat threatening degree of activity of the latter. Possibly the lake was there, but it was invisible from my standpoint.

Shortly after my arrival in New Zealand—in November, 1896—the newspapers reported that eruptions had taken place at Te Mari. I visited the volcanoes for the first time in December, 1896, and Ngauruhoe first of all. At that time Te Mari was always steaming furiously, and sometimes emitting dark, dense, brownish-grey clouds, the appearance of which indicated the presence of ashes.

On the afternoon of the 11th December, 1896, I found myself shrouded in mist and rain on one of the eastern ridges of Tongariro, and I heard distinctly, for some minutes, a continuous roaring and thundering in the direction of Te Mari.

On the evening of the 14th December, 1896, I was encamped on the northern slope of the North Crater, about an

hour's walking distance from and beneath Ketetahi. That day Te Mari was steaming less than it had done on the previous days, and scarcely more than Ketetahi; but the slightly bluish colour of its steam betrayed a somewhat higher temperature. But for this fact one might have thought the period of activity was almost at an end, and I little hoped that I should witness one of those eruptions of which I had so often heard or read. We were sleeping quietly in our camp when, at about half-past 12 o'clock, we were awakened by a thundering noise, and on going out of our tent we beheld a very remarkable spectacle—indeed, I afterwards heard that at Otakou the natives had already commenced leaving, and would have left altogether but for the short duration of the violent phase of the outbreak.

Against the starlit and cloudless sky stood a gigantic pillar of ash-bearing steam, broadening towards its summit, and overtopped by a detached roundish mass of the same appearance. Evidently the explosion had begun by a single shot, followed by a rest of some seconds. The pillar of steam —as ash-bearing and other volcanic clouds always are, as long as they are in ascending movement, hotter than the surrounding air—was of an exquisite cumulus character. This and its absolute opaqueness and dark colour gave it a strange appearance, almost like that of a solid body—an enormous stalagmite, as it were. But the most surprising sight was the wonderful display of different kinds of light phenomena. Whereas at no time had I seen the slightest fire-reflection above Te Mari, the lower parts of the steam column were now all aglow with a dark-red glare. A large number of what looked like bright sparks shot high up, and fell down in parabolic lines. There was going on, besides, a continuous play of electric lightning in the clouds, mostly, but not always, in the lower parts. I think there was on the average fully one lightning flash to the second. These lightning flashes did not differ from ordinary flashes except that they were mostly rather short; their being confined to one spot of the sky, and their wonderful frequency, made, too, a very curious impression. The thunder blended together and formed a continuous roar, which, however, at our station was not deafening. But the most remarkable and interesting phenomenon had yet to come. The upshooting sparks (here I describe the immediate impression only, giving the explanation later on) by degrees became rarer, and the lightning also; and then there appeared large flames of a brilliant-blue hue, which mingled with the ascending steam—apparently floating, as it were, free in the air at some distance above the mouth of the crater. I estimated the height of the flames at about 100 ft.

About a quarter of an hour after its commencement the

eruption proper was over—the glare faded away, the sparks and the flames disappeared, and the lightning stopped. Now and then, at longer intervals, there were one or two flashes, but soon nothing was left but a great pillar of steam and smoke that continued slowly to rise, and the top of which, losing its sharp rounded outline of a cumulus cloud, began to spread. Its height must have been very considerable, as it reached our zenith apparently—but only apparently, as we did not receive any ashes at our standpoint.

These observations were made from the camp mentioned above, on a perfectly clear night and with a very good binocular of 6-diameter enlargement, and therefore I am absolutely certain of my statements. There were at least four different light phenomena—(1) The reflection of the incandescent matter on the steam; (2) what I called the sparks; (3) the electric lightning; and (4) the blue flames. Besides the latter, there seemed to be sometimes reddish flames; but this I cannot state with absolute certainty, as from a distance it is almost impossible even for an experienced observer to distinguish with any degree of certainty illuminated steam and supposed reddish flames.

The above-described eruption seems to me to be remarkable in more than one respect; it evidently was one of many similar eruptions which had been mentioned by the newspapers. One of the characteristics of Te Mari's activity, therefore, was its intermittency; but not its only one. What surprised me most was the display of incandescent matter during the violent phase only, whereas before and after nobody would have believed in the presence of red-hot magma, as, with the exception of that explosion — lasting about a quarter of an hour—no fire-reflection was visible.

What looked like and were described as "sparks" were the large number of red-hot boulders that were shot up. The impression was that the fusion was very imperfect, the magma very viscous, and scarcely as hot as that of Vesuvius, Etna, or Stromboli, not to speak of the white-hot and most perfectly molten lava of Hawaii. It is difficult to tell why the magma, in the shape of reflection and red-hot stones, was visible only at intervals, for this probably has been the case at more than one eruption, as most of the newspaper reports state that there had been "fire," and not only smoke, whereas during the long time between the short paroxysms Te Mari looked rather harmless, and little more than a lively solfatara.

As to the electric lightning, there is but little doubt that the source of electricity is the friction. This was the second time I had observed volcanic lightning, and in both cases it appeared in masses of ash-bearing steam; and the ashes were coarse, the single grains being about the size of a pin-head.

The ashes of the explosion I witnessed were collected at Waihohonu by Mr. Peters, from whom I obtained a small bottleful. A European settler at Otakou told me that the lightning was seldom so lively as during the night of the 14th December, 1896, and that most of the ashes produced by Te Mari were very fine, and almost like flour. Perhaps, therefore, coarse ashes favour the development of electricity by increasing the friction.

As to the flames, I need not remind you that frequently flames in volcanoes have been described—and doubtlessly will be described—which were only illuminated steam or smoke. In popular descriptions, out of a hundred alleged flames ninety-nine are certainly not flames. Most excursionists to Vesuvius report seeing flames though there are none. Therefore the very word "flame" in connection with volcanoes is apt to cause suspicion. The only thing I can do is to repeat that I am quite certain that I saw illuminated steam frequently. The reflection of incandescent matter on steam can imitate the appearance of flames of the ordinary colour—and it frequently does—but it never can produce the effect of *blue* flames. Of the reddish flames, therefore, I am not so certain; but we must admit the fact of the blue flames. The only explanation, moreover, which fully agrees with the appearance of those flames is that during the explosion there escaped combustible gases which at a certain height above the crater met the oxygen necessary for taking fire. I believe that vaporized sulphur would answer all the facts better than hydrogen, the flames of which are less brilliant and less distinctly blue.

The only specimen of volcanic activity similar to that of Te Mari that I know of by personal observation is the small volcano on the southernmost of the Liparian Islands (north from Sicily) called "Volcano." This little volcanic cone, after a long rest, resumed activity in 1888—August, I believe—emitting, at intervals, huge masses of ash-bearing steam, and sometimes large incandescent bombs, but no outflow of lava. I visited it in June of 1889, when it was making explosions similar to that of Te Mari. The explosions were, however, more frequent, there being many in one day; but they were less violent—at any rate, during my presence. The recently discharged bombs betrayed the fact that there had been magma in the depths, as their surface showed evidence of fusion; but during my presence no bombs were thrown. Besides, Volcano, in the intervals between two explosions, was perfectly quiet, and not even from the crater-rim was any smoke or steam visible at its bottom, allowance being made for some fumaroles on the outer slope of the cone. Te Mari, however, was always steaming; and after the explosion

proper it kept on steaming furiously, though with slowly decreasing power. This I observed on one occasion, and I was told that it was generally or always the case.

I had no time to make a petrographic study of Tongariro, and my few specimens are not yet analysed. I know, also, that rather basic rocks have been found in the Tongariro system. Tongariro, however, if compared with Vesuvius or Etna, probably is, as well as Volcano, far more acidic, whereas the Hawaiian volcanoes are known to be ultra-basic. It is therefore perhaps worth mentioning that the character of the activity of these volcanoes to a large extent forms a similar series, as does their chemical composition. We find, in fact, in Hawaii enormous masses of very liquid and almost white-hot ultra-basic lava, and only a very slight amount of steam. We find the reverse in Te Mari and Volcano—very powerful explosive-like eruptions of steam and ashes, whereas the presence of magma betrays itself only occasionally. In fact, any one who did not happen to witness one of these paroxysms at night-time might doubt the presence of red-hot magma altogether. The colour of the glare, moreover, showed a vivid red heat only; and the rather angular shape of the erupted rocks denoted a very imperfect fusion, if any. Also, the structure of the very cones—the appearance and steepness of the old lava-currents of Ngauruhoe—shows that the lava must have been viscous. Vesuvius and Etna, which, chemically, are between Hawaii on one side and Tongariro and Volcano (Lipari) on the other side, are also, in their dynamic behaviour, intermediate. Their lava-currents, which I observed frequently, as well as those of Hawaii, are less liquid, and apparently also less hot, than those of the Hawaiian volcanoes; but the lava, besides the steam, plays a very important part in their activity. A great display of high-pressure steam and comparatively little lava, therefore, seems to be a characteristic of the more acidic volcano, whilst the opposite feature is a characteristic of the more basic one. This apparent rule, however, needs confirmation by further comparison.

In another respect Te Mari's activity is interesting; it shows that the appearance of molten, or at least incandescent, rock—viz., a shower of red-hot projectiles and a glare in the lower parts of the ascending steam—sometimes lasts a very short time only. After a personal inspection of Tarawera and Ruawahia I never doubted but that there had been molten rock, but no lava-stream proper; and after my experience with Te Mari I am, if it were possible, more certain still. It has been questioned by persons who visited Tarawera after the main explosion was over—viz., after the morning of the 10th June, 1886—if there had been any incandescent rock, and

it has even been found proper to invent a new term by denominating that destructive outburst a "hydrothermal eruption." This term may be correct in so far that the waters of Rotomahana played a part in the eruption of Tarawera proper, or at least altered the phenomena somewhat; but, as it involves the theory that incandescent magma had no important part, if any, in the whole remarkable eruption, I cannot indorse it.

Next day I went to Ketetahi, where I saw some very fine and powerful high-pressure fumaroles, a great number of minor steam-holes, and a considerable pool of turbid hot water, the overflow of which formed a hot creek. Ketatahi is the most beautiful specimen of a fumarole I have ever seen: it is far superior to Karapiti, or any of the others in the geyser district; and it is also superior to those in the Yellowstone Park or in Italy. The whole place had, as is usual in hot-springs districts, a smell of sulphuretted hydrogen (H_2S).

After this I ascended the North Crater, went to the top of Tongariro, came back again to the North Crater, and walked over to the Blue Lake, and everywhere I found the surface covered by a thin layer of very fine bluish-grey dust. From the Blue Lake I descended to the northern slope, approaching Te Mari within about 300–400 m. Te Mari had quietened down considerably in the afternoon, and its steam was almost white—*i.e.*, without ashes—but I did not dare to go to its rim after my experiences of the previous night, as a sudden new outbreak, with enormous masses of steam, bombs, and lightning, might have proved very dangerous.

II. Ngauruhoe.

I have but little to say about Ngauruhoe. After the information I have received from old settlers and from Maori scholars (compare also what Mr. Willis says in his guide-book) I feel inclined to believe that "Auruhoe," and not "Ngauruhoe," is the right name. I ascended the cone on the 8th December, 1896, over the saddle between its base and the south-eastern spur of the Tongariro system—viz., from about the north-east. The upper parts have a slope of about 35°, and are mostly formed of solid lava. Viscous lava only is likely to build up a cone of that steepness. On the lower parts cinders prevail. From the slope and from the top a magnificent bird's-eye view of the Tongariro system is afforded. The crater may be considered as sufficiently known. Its rim has a gap in the north-west or north-north-west; its bottom contains one small cone of somewhat solid-looking matter, and, besides, a large and typical broad secondary cinder-cone. The latter is very excentric towards the north-west—in fact, its slope, in the already-

mentioned gap* of the main crater-rim, is confluent with the slope of the great cone of Ngauruhoe itself. This is correctly represented on the above-mentioned survey-map. In the south-west part of the crater there is a large hole, the details and bottom of which are hidden by the large amount of steam which is constantly coming out. By far the greater part of the steam had its origin in that hole, though there were many other places steaming.

Two facts betrayed a very low degree of activity—the presence of considerable masses of snow in different parts of the crater and the smell of sulphuretted hydrogen (H_2S). It is to be hoped that the expression "sulphur-fumes," or similar words, will go entirely out of use in descriptions of volcanoes, for they convey three very different meanings—viz., pure sulphur (S), sulphuretted hydrogen H_2S), or the dioxide of sulphur (also called sulphurous acid) (SO_2). The latter two, moreover, exclude each other, as they readily combine to form water and sulphur. The first one—pure sulphur—is found together with the second in many fumaroles. The last one—SO_2—is an indicator of a very much higher temperature and volcanic activity. As everybody's nose easily distinguishes between the irritating, cough-producing, and choking SO_2, the unpleasant smell of H_2S, and the rather insignificant odour of pure sublimating sulphur, I cannot see why the ambiguous term "sulphur-fumes" plays such an important part in many reports. Even the very bad smoke of Vesuvius, which to noses not quite chemically untrained of course indicates the prevalent presence of quite a different exhalation—viz., hydrochloric acid (HCl)—is very frequently libelled as "sulphur-smoke." Ngauruhoe was working with the comparatively harmless H_2S, while in Te Mari there seemed to be SO_2; but, as I was always on the lee side, I am not sure.

As to the relation of the Tongariro system to Ngauruhoe, it is scarcely necessary to say that the former cannot be looked upon as the "somma" of Ngauruhoe. This is one of the very few mistakes I found in Hochstetter's excellent book "New Zealand," a mistake the more excusable as Hochstetter, as he states himself, was not able to visit the volcanoes on account of the native *tapu*. The only formation that perhaps may be a "somma" of Ngauruhoe is a series of hills in the south, between the cone and Nga-puna-a-tama; but, as I saw those only from a distance—from the slope and north top of Ruapehu—I could not express a certain opinion. The reason why Tongariro cannot be styled a "somma" of Ngauruhoe is double—first, it does not surround the cone of Ngauruhoe; and, second, it bears a number of craters on the top. A "somma" is the rim of an old crater, and therefore, as its prototype, has no vents on its top.

III. Ruapehu.

Ruapehu I ascended on the 4th April, 1897, from the saddle between Ngauruhoe and Ruapehu. I am greatly indebted to R. T. Batley, Esq., at Moawhango, for having provided me with good horses, an excellent companion, and good advice. The most important thing is to camp out as high as possible, in order to arrive at the top early the next day, and to have plenty of time for exploring the extensive summit.

We succeeded in finding, far above the apparent line of good camping-ground, a detached patch of bush, where there were also water in some pools of a lava-gully and tussock-grass for the horses. From that place, the next day, we reached the north summit, Te Heuheu, in 3 hours 35 minutes, partly riding and partly walking. The slope was in many places free from snow, and we walked mostly on a ridge, skirting a small *névé* on our left (in ascending). The slope I estimate to be about 20° only.

The summit of Ruapehu is, roughly speaking, a vast, oblong, almost level plain, covered with *névé*—viz., hard snow—and surrounded by a number of rocky peaks, the most prominent of which are in the south, south-west, and north.

Before entering into a further description a few more general remarks may not be out of place. Ruapehu surpasses the snow-line considerably—*i.e.*, that height above which more snow falls than can be melted. On mountains like this the excess of snow is counterbalanced, as we know, in that a part of the snow travels to lower altitudes—partly as avalanches, partly as glaciers—to be melted down below. Now, suppose a volcano surpassing the snow-line, and provided with a crater right on its top: if the crater-rim be intact, of even height all round, and no internal heat existent, the snow is bound to fill up the whole crater, and to overtop or, as it were, overflow its rim on all sides. In this case the crater must be obliterated entirely; one would find a snow-dome on its top, without any trace of a pit or hole. But as soon as we suppose the crater-rim to have one or more gaps the streams of *névé*, or glacier ice, can escape; and the upper parts of the inner slopes of the crater, which generally are very steep, and therefore do not hold much snow, will become visible. The drainage of frozen water, which in the former case will occur evenly all over the rim indiscriminately, in the latter case will be confined to the gaps, if they are of any extent. Instead of a complete gap, it would be also sufficient if the rim were lower on some parts than on others: the lower parts would be overflowed by the *névés* and the upper ones become free from snow. Anyhow, the deeper part of the crater-bottom must be covered by everlasting snow.

The crater of Ruapehu, at first sight, does not look like a crater at all. Closer and reflecting inspection, however, shows that the inner slopes of all the rocky peaks surrounding the snow-covered plain are much steeper than its outer. This and a smell of sulphuretted hydrogen, that every now and then was brought over by the cold southerly wind, reminded us of the volcanic nature of the mountain.

After having photographed the panorama from the north peak we descended its steep and partially ice-covered inner slope (it is not advisable for everybody to do this, as it is better to make a detour by going round on the outer slope, saving risk and perhaps time) and crossed the snow-field to the lake. Having photographed the latter, I ascended the south-western peak, on which is a trig. (cross), and took a panoramic view from near its top, the wind being too strong on the very top. Therefore in writing this I can help my memory by two panoramic views taken from two different points.

It seems to me to be questionable whether the top of Ruapehu is one crater only or whether it is two craters. The trouble is that the larger part of its bottom is hidden by *névé;* but on account of its enormously elongated shape and its rocky ridges and minor peculiarities I almost feel inclined to believe that there are two adjacent craters, a feature not altogether unknown with volcanoes, though exceptional. But this is hypothesis only. I feel, however, almost certain of the correctness of another interpretation which, I believe, has not yet been pointed out by previous visitors to the top—viz., that the famous lake (which, by-the-by, was steaming slightly and was apparently tepid) is situated not in the main crater (or, if there be two, in the southern of the two craters which cover Ruapehu's top), but in a secondary cinder-cone. I think no one who has seen a number of volcanic mountains would doubt this for a moment. The other parts of the rim, however, were almost entirely hidden by *névés*, the greater part of which started from the south peaks and the south-west peak, and ended at the lake abruptly in very steep ice walls. The *névés* hanging down the inner slopes of the south peaks look like real glaciers—*i.e.*, ice-grey. The secondary, or inner, cinder-cone, which on the eastern side is rather high, and even forms a prominent point, visible from the north peak, must be lower or perhaps destroyed on its western parts.

If we suppose this cinder-cone to be active as an ordinary solfatara—*i.e.*, in quite a similar way and degree to Ngauruhoe—then, I think, we can easily understand the formation and the behaviour of the celebrated lake. Suppose hot water, steam, and sulphuretted hydrogen escaping from the bottom of the secondary cone: if Ruapehu did not mount above the snow-

line that steam would rise and betray Ruapehu as a slightly active volcano at a distance. But Ruapehu does mount above the snow-line, and the steam at first is used up for melting the snow it meets. This is the obvious origin of the lake. The cinder-cone is very excentric near the eastern rim of the southern part of the main crater. There the snow would soon be melted, and the temperature of the water might rise, if it were not for the other sides of the cone, where (more especially from the rather extensive inner slopes of the southern and south-western parts of the main crater-rim) *névés* or glaciers hang down, and, according to well-known laws of movement of glaciers and *névés*, move towards the deepest place—that is, the lake. Thus, whereas the steam has the tendency of raising the temperature of the water, the *névés*, of course, do the reverse. The result must depend upon the relative power of the two antagonistic forces. If steam from the depths be plentiful, and the glaciers be slow, the warm water and the steam rising from its surface may melt the snow at a certain distance, and prevent any considerable amount of frozen water from touching the lake; and then, of course, its temperature might reach boiling-point. In that case the steam from the depths would not be condensed any longer, and the lake, under such circumstances, might exhibit geyser-like phenomena. If, on the contrary, the steam from the depths be scarce, or the masses of snow travelling towards the lake be large and their rate of progress fast, the temperature would be kept down and no steam could escape, as it is readily condensed in the cold or only lukewarm water.

Ruapehu, I think, may be fully as active as Ngauruhoe (as I found it) without appearing so. There was snow in the crater of Ngauruhoe, and if Ngauruhoe were higher there would be more snow; again, if the crater were larger there would be accumulated snow; and if the steam had to deal with sufficient masses of snow it necessarily would form a lake, which it does on Ruapehu where the above conditions prevail.

It may be asked, What becomes of the water of the lake? A part, doubtlessly, evaporates; but it seems very probable that the River Wangaehu receives water from the lake by percolation. The lake is contained in a cinder-cone, situated excentrically, at the south-eastern rim of the main crater. The visible eastern surroundings of the lake are masses of dark cinders, which, of course, are easily permeable. The Wangaehu River starts from the eastern slope of Ruapehu, and its waters, as well as the waters of the lake, are turbid, and have a smell of sulphuretted hydrogen. Taking these facts into consideration, there can, I think, be but little doubt that this is the way the water takes.

It may be convenient to express my opinions concerning Ruapehu in a few short sentences:—

(1.) What is considered to be the crater of Ruapehu is possibly, in truth, two adjoining craters.

(2.) The rim of this crater (or these craters) is most perfect on the south, south-west, and north.

(3.) The snow-drainage of the crater takes place through large gaps, in the shape of *névés* or glaciers hanging down from the rim to the outer slopes of the mountain.

(4.) The southern portion of the main crater (or, if there be originally two, the south crater) contains a secondary cinder-cone, situated excentrically on the eastern edge.

(5.) This cinder-cone is active as a solfatara, emitting hot water, steam, and sulphuretted hydrogen.

(6.) The result of the conflict between the steam and the *névé* is the formation of the lake.

(7.) Its temperature depends upon the amount and temperature of steam on the one side and the amount and rate of *névé* travelling towards it on the other side.

(8.) The lake mostly acts as a steam-condenser, and hides, as it were, to some extent, the activity of Ruapehu.

(9.) Most likely Wangaehu draws water from the lake by percolation.

Some Practical Hints to Visitors to the Volcanoes.

As any one of the three volcanoes, in the author's opinion, exceeds in interest for ordinary tourists and in scenic beauty the whole of the hot-springs district, it is time they were made more accessible to the general public. Though none of them offer any difficulty whatever to fairly good walkers—mountain-climbing capacity proper is not required at all—it takes a good deal of trouble and, to those unacquainted with persons and circumstances, considerable expense, to get the desirable outfit on the spot, and the trouble is even greater perhaps in the case of foreigners. If good guides and outfits were obtainable at reasonable charges, and the trips were duly advertised, these marvellous volcanoes would soon not only become better known and appreciated, but would also contribute to the income of the country. I should advise everybody not to avoid a little detour if the chances of getting a proper outfit appear to become better by doing so. For the ascent, and even more so for the descent, of the mountains, especially the line of Ngauruhoe, a long strong stick is very handy. Ngauruhoe's cone in places is just steep and smooth enough to render rolling stones dangerous to those standing beneath. To traverse from east to west the cones of Tongariro on their slope is very tedious, on account of the many gullies. An ice-axe is sometimes handy on Ruapehu.

The place of our camp on Ruapehu is given by the following bearings: North peak, 146°; needle-like rock, 128°; top of Ngauruhoe, *ca.* 18°.

The aim is taken through dioptra from south to north. North has the figure 0, or 360; east the figure 90; south the figure 180; and west the figure 270. The given bearings indicate the reading of the north end of the needle. Therefore the reading 0 means that the object is towards the north; reading 90, towards the west; reading 180, towards the south; and reading 270, towards the east.

The needle-like rock on the right outline of the slope of the north peak is unmistakable. If you should be in doubt, there being some sharp points, take the one most to your right. I could not warrant there will always be water in the gully, but I believe there is generally.

Always take bearings from your camps before leaving them, the more so on the rolling tussock-plains or on the lower parts of the slopes. The bush-patches are difficult to identify from above, and when you return it is unpleasant to be in doubt as to where your camp and your provisions are waiting for you. This I mention out of sad experience.

Art. XLIX.—*The Volcanoes of the Pacific.*

By Coleman Phillips.

[*Read before the Wellington Philosophical Society, 17th August, 1898.*]

Plate LI.

First Line of Activity.

In December, 1894, I went down to Tonga and Samoa from Auckland in the s.s. "Upolu." Whilst lying at the wharf at Nukualofa, the capital of Tongatabu, the most southern of the three great islands of Tonga (the middle one being named Hapaai and the northern island Vavau), the steamer was shaken against the wharf by a sharp earthquake shock. No one took any notice of the matter, as earthquake shocks are common in Tonga; but it led me to inquire further into the question, and my inquiries resulted in finding that the situation of this particular group of islands will be found most interesting to the student of earthquake phenomena in the Pacific.

At Auckland I was well acquainted with the remarkable group of extinct volcanoes surrounding Dairy Flat—including

Mount Eden—upon the isthmus connecting that city with Onehunga. We all know the phenomena of our hot-lakes district, White Island, and the Hanmer Plains. The Kermadecs are also volcanic, and liable to great earthquake shocks. The longitude of these spots, roughly calculated from the poor maps in a country library, is as follows: Hanmer Plains, 172° 45′ E.; Tongariro, 175° 48′ E.; White Island, 177° 12′ E.; Auckland, 174° 45′ E.; and the Kermadecs, 178° W.

The distance from Tongariro to the Whakaari Volcano (White Island) is 120 nautical miles. Over the whole distance, according to Dr. Hochstetter in his geology of New Zealand, almost in the very line between these two active craters, volcanic phenomena "seethe, bubble, and steam from more than a thousand crevices and fissures that channel the lava-beds of which the soil consists, a sure prognostic of the still smouldering fire in the depths below; whilst numerous fresh-water lakes—of which Lake Taupo is the largest (twenty miles in diameter)—fill up the large depressions of the ground. This is the lake district so famous for its boiling springs, its steaming fumaroles, solfataras, and bubbling mud-basins." I give the extract now, in order that members may fully realise the phenomena close to their doors—along a distance of 120 miles—before I carry them to the evidences of much greater phenomena in the Pacific.

Mount Egmont is also an extinct crater: longitude 174° E.; height, 8,280 ft.

Almost every volume of our Transactions contains valuable references and tabulations by Sir James Hector of earthquake phenomena, to which I refer members; and I would also refer them to the excellent earthquake papers by Professor Hutton, Mr. A. McKay, Mr. Field, and other contributors. We live in New Zealand in the midst of unaccountable earth-movements, as it were; but it may be that by arranging for the establishment of seismitic stations in the neighbouring islands of the Pacific—to which I am about to refer—we may begin to understand the cause of these movements a little more clearly than at present. In one of his papers* Mr. McKay placed the centre of the 1888 disturbance of September and October in the Amuri district (Hanmer Plains), at Glen Wye, the force of the shock diminishing in all directions from this particular part, and Sir James Hector agreed. Perhaps by throwing into one paper all the facts at my disposal of Pacific phenomena a wider range for earth-movements will be granted by geologists.

It has been stated that during our great Tarawera eruption

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* Trans. N.Z. Inst., vol. xxi., p. 509.

of 1886 the volcano of Kilauea, at the Sandwich Islands, was extremely quiescent.

I fancy, also, that Professor Milne's seismometers register earth-movements to a distance of three thousand miles, and that *through* an arc of the globe; and it has even been stated that a late great earthquake in Japan was felt at the Isle of Wight, in England.

The object of this present paper is only to collect and supply the detailed information concerning the volcanoes of the Pacific, which I scarcely think other writers could have had the opportunity of observing.

It will be found, I think, that usually an outburst at one place affects some other place perhaps three or four hundred or even a thousand miles away, and sometimes even at a greater distance.

A late issue of the *Rangitikei Advocate* says: "It would appear from the conformation of the country around Ruapehu that the district for a considerable distance has been subjected to a periodical covering. The surveyors who have had occasion to dig trenches have found 1 ft. of soil 3 ft. below the present surface, after having gone through various thicknesses of scoria and pumice, which makes it very probable that Ruapehu has a periodical burst-up." Such periodical outbursts may imply internal pressure accumulating from a great distance.

The shock of the great earthquake that destroyed the City of Lisbon (1st November, 1755) pervaded an area of 700,000 miles, or the twelfth part of the circumference of the globe. "It was felt in the Alps, on the coast of Sweden, into the Antilles, Antigua, Barbadoes, and Martinique; in the great Canadian lakes, in Thuringia, in the flat country of Northern Germany, and in the small inland lakes on the shores of the Baltic. Remote springs were interrupted in their flow, and the hot springs of Toplitz dried up and returned, inundating everything around, and having their waters coloured with iron ochre. A portion of the earth's surface four times greater than that of Europe was simultaneously shaken."

I wish, therefore, to call the attention of members to volcanic phenomena in the Pacific, in order that we may better understand what is occurring here in New Zealand.

The longitude of the Tongan group lies between 172° and 175° W. At Nukualofa I had the pleasure of meeting Mr. C. D. Whitcombe, the courteous Foreign Secretary of the little kingdom, who informed me that he had just returned from investigating the remarkable phenomena at Falcon Island. This was the island which a few years previously had been thrown up in a night, where formerly a reef only —named the Falcon Reef, after H.M.S. "Falcon"—existed.

In the same month—December, 1894—when I was at Tongatabu, the report had come in that Falcon Island had disappeared. Reports had previously been made that the island was gradually washing away, the sea being discoloured all around for some five miles owing to the erosion. The Tongan Government therefore, on the 21st December, sent Mr. Whitcombe down, with Captain John Cassels, Acting Harbourmaster, and some other gentlemen, to inquire into the actual state of things at the island. Falcon Island lies about forty-five miles north-north-west of Nukualofa, in longitude 175° 20′.

Captain Cassels and a Mr. O'Connor swam through the surf, which there swarmed with small sharks. They found the island to be "cold, steep, water of 20 fathoms all round, about a mile and a quarter in diameter, and three and a half in circumference. At the southern end about 50 ft. high; in the centre a fresh-water mineral lake about 4 ft. to 5 ft. deep, with a solid-rock bottom. In places very hot to the feet, as Mr. O'Connor found." They had to take their boots off when swimming from the boat, which lay outside the surf. The island itself was a mass of red and black scoria, whose gradual washing-away caused the discolouration of the surrounding sea. I have given Captain Cassels's own words concerning his visit. I also present to our Museum specimens of the red and black scoria, and of the solid-rock bottom of the lake, which Captain Cassels tied up in his shirt when swimming back to the boat. The formation of the scoria is remarkable. The little spheres and oblates, if water-worn, must have been so formed by submarine action, as there was no active volcano on the island, and little vegetation, so far as I could make out. The black scoria is partly composed of the little hollow bombs, somewhat similar, I believe, to those thrown out in the great eruption of Tarawera in June, 1886, and at other times before and since. The formation of these little bombs is no doubt easily explained. But in Miss Bird's account of the great eruption of Mauna Loa, Sandwich Islands, in 1868, the volcanic phenomena there displayed forces in nature of which we know little or nothing. The motion of the land during the eruption was "vertical, rotary, lateral, and undulating"; mountains fell and split up in all directions; the surging of the imprisoned lava was heard through the ground; its flow of twenty miles underground; its bursting through the soil in huge fountains, rotating towards the south; "in the air both lava and stones always rotated towards the south."

It will be noticed, too, that the black scoria gravel is much smaller than the brown gravel; but this may be only a small local difference in the strata. I am well aware that the lava from different volcanoes is different. The solid-rock bottom

appears to be volcanic tufa. Sir James Hector tells me that this is a very interesting rock, being a form of rhyolite containing spherulitic grains of pearlite embedded in a rough silicious and feldspathic base, which also contains sparkling grains and subcrystalline groupings of white iron-pyrites. The rock is a most beautiful object under the microscope with a strong direct illumination.

I also include the following description of his visit, which Mr. Whitcombe gave me verbatim: "I was sent with Captain Cassels on the 20th December, 1894, to report upon Falcon Island. On the 21st, at noon, Falcon Island loomed on western bow, northward; Tofua and Kao on eastern bow. Boat put off from ship to visit it. Report required because one ship had reported its disappearance and another ship had stated its emergence and extension, with discoloured water five miles round. Captain Cassels, Mr. O'Connor, and Bolutele (the Premier's clerk) accompanied me. Landing very difficult, as seas dashed up the steep slopes of island. Deep water (40 fathoms) close to island. Discoloured water three to four miles from island caused by detritus from it. Party had to wade and swim to island, taking a rope and leaving a man in boat. Shoals of small 5 ft. to 7 ft. sharks assailed us. Found island covered with coarse black gravel. Water in lagoon very clear, with strong mineral chloride flavour. In one part the soil of the island was red-hot, so much so that it blistered Cassels's and O'Connor's feet. South-east end of island highest part—50 ft., varying to 20 ft. Circumference of island, four miles. Length, a mile and a half. Tongan Ensign hoisted, and fourteen cocoanut-trees planted. Taken possession of in name of King George II. of Tonga. Its name, Kahekahe Fefine (woman). This island (Falcon) sprang up in 1885. Another island which had sprung up some years previously between Late and Kao the king named Kahekahe Tangata (man)."

In my scrap-book I find the following extract touching the first appearance of the island: "The intelligence officer of the American warship 'Mohican' forwards the following to the Press: 'In compliance with instructions received in July from Admiral McCauley, the American corvette "Mohican," Commander Day, made a special trip to an island formed by volcanic action since October last. At a distance of fifteen miles steam could be discerned rising in the air above the former site of the Falcon Shoal. On arriving at the spot the "Mohican" steamed round, taking bearings of its positions, and sketches and photographs of its contour and appearance. The island is of circular shape, 230 ft. high, and a mile and a half wide. It has a steaming crater on the east side. To the extreme west there is a noticeable wreath of smoke. On

taking soundings good anchorage was found on the north side of the island. The longitude is 175° 20′ W., and the latitude 20° 20′ S. The island is situated forty-eight miles north-north-west of Nukualofa. The impression conveyed by its appearance was that the bed of the ocean had been uplifted out of the water.' "

The island had therefore lost 180 ft. in height between its upheaval in October, 1885, and Mr. Whitcombe's visit in December, 1894. There is nothing very remarkable in this, as volcanic islands have been thrown up and subsided in European seas. The lavas, scoria, ash, or tufa of which they are composed are particularly subject to the wear-and-tear of rain, wind, and tide, and more especially of tidal wave, or, rather, earthquake wave, which is awfully destructive. The above data, however, are interesting.

I also give an extract from our Wellington shipping news of 1895 concerning H.M.S. "Penguin's" cruise and survey: "H.M.S. 'Penguin,' which came into port yesterday afternoon, has been engaged since July last in surveying from Auckland to Tonga, thence to Samoa, and back to Tonga, in addition to surveying at the Falcon Islands. Her officers claim that they have the record for deep-sea soundings, and certainly some very extraordinary depths were obtained. The warship left Nukualofa, Tonga, on the 21st December, and on the 26th soundings to the extent of 4,940 fathoms were obtained, but the wire which was being used parted and was lost. Later in the day, however, 5,022 fathoms was reached, in latitude 23° 39′ S., longitude 175° 4′ W. On the 30th December a depth of 5,147 fathoms was reached, in latitude 28° 44′ S., and longitude 176° 4′ W. On the 31st December, however, the still greater depth of 5,155 fathoms was reached, in latitude 30° 27′ S., and longitude 176° 39′ W. Red clay was brought up from the greatest depth. The 'Penguin' takes in a supply of coal here, and sails on Saturday for the Bluff, and thence to Hobart, taking soundings as she goes."

Upon the above, Rear-Admiral Wharton, writing to the *Times*, remarks: "It may interest some of your readers to know that some spots have recently been found in the South Pacific Ocean where the water is deeper than anywhere hitherto known. Her Majesty's surveying ship 'Penguin,' while returning from the Tonga Group to New Zealand, has sounded in three places where the depth exceeds 5,000 fathoms. Up to the present the deepest water found was to the north-eastward of Japan, where in 1874 the United States steamer 'Tuscarora' obtained a cast of 4,655 fathoms. The 'Penguin's' soundings are 5,027, 5,147, and 5,155 fathoms. The increase is therefore 500 fathoms, or 3,000 ft. These

soundings are separated from one another by water much less deep, and the bottoms may not be connected. The distance from the two extreme soundings is 450 miles. Specimens of the bottom were recovered from the two deeper soundings, and prove to be the usual red clay found in all the deepest parts of the oceans. These soundings afford additional evidence of the observed fact that the deepest holes are not in the centres of the oceans, but are near land, as two of them are within a hundred miles of the islands of the Kermadec Group, and the other not far from a shoal. Doubtless deeper depressions in the bed of the sea are yet to be found, but the fact that this sounding of 30,920 ft. shows that the ocean contains depressions below the surface greater than the elevation of the highest known mountains is perhaps worthy of record."

As to the question of heights and depths, a sounding has recently been taken in the Pacific Ocean, near the coast of Japan, which shows a depth of 29,400 ft., or approximately five miles and a half. This is a little more than the height of the loftiest mountain—Mount Everest—which is situated in the Himalayan Range, to the north of India. It has been suggested, as one theory of the formation of mountain-ranges, that they represent the crumpling-up, or buckling, of the earth's crust under the severe contraction strains that were set up as the surface of the globe solidified. If this be true, the deep ocean valleys or gorges, such as this off the coast of Japan, must be the result of the same action. Taken in connection with the loftiest mountain, this sounding gives a difference in distance from the earth's centre of about twelve miles, or 1·333 of the earth's radius.

On our way to Tonga we passed Pylstaart Island (22° 23′ south latitude, 176° 7′ north longitude; height, 700 ft.; uninhabited), which I certainly should consider to be formed by volcanic upheaval.

The visitor to Tonga cannot fail to be struck by the numerous little islets standing upon the reefs at the different entrances to Nukualofa and Vavau—their flat tops and steep sides, and how the waves are undermining them and wasting the solid coral away. He naturally concludes that these little spots must have been upheaved from the sea, and that not so very long ago, and by one and the same upheaval.

On the 28th the steamer left Nukualofa for Hapaai (distance, 132 miles). On the way I noticed Tofoa, or Tofua (1,890 ft.), and Kao, two grand huge dim-looking mountains running up to 3,000 ft. I think Tofua is more constantly in action than Kao (3,030 ft.), which only emits puffs of steam occasionally from its sides. Longitude, about 175° W. The weather was too thick for us (after leaving Hapaai for Vavau) to notice the smoke of the volcano on Tofua. (It was to that

island the poor Wesleyan Tongans were deported during the late religious persecutions there.)

I did not see Metis Rock, about thirty miles south-west of Vavau. This little island is composed of almost solid sulphur. Hundreds of tons could be gathered there. The rock is about 100 yards in diameter and some 20 ft. high. There is no anchorage; a vessel would have to lie off and on. The rock, of course, is purely volcanic, as it is constantly seen emitting small puffs of steam. Calm weather, May, June, and July. Mr. A. W. Mackay, of Nukualofa, who has visited the rock, kindly gave me this information. Longitude, 174° 47′ W. Boats and punts would have to be used for loading the sulphur, but the Union Steamship Company's steamers could call for quantities, say, of 50 tons at a time.

Mr. Whitcombe has since written to me as follows: "Metis Island, in the Vavau Group, was last in eruption in 1886. It is called by the natives generally Fonua-fooa (new land,) and is about 151 ft. in height.* There is another Fonua-fooa in the Tongatabu Group—viz., Falcon Island. Metis is a rock of no great size—perhaps a mile in diameter, with a boundary reef round it. Large deposits of sulphur may also be found on Late Island, and also on Fonualei Island. These islands are seldom visited. Deep water up to reefs, and also deep water inside (with occasional inner reefs and shoals), with one or more deep-water channels leading from the ocean into the inner water. No fresh water on any of them. With the exception of a small brook on Eua, there is not a running stream on any of the islands of the Tongan Group."

I might be allowed to digress here to give a brief list of other sulphur deposits in the islands besides Metis Rock, seeing that there has been a scarcity of sulphur lately, owing, I believe, to the Spanish-American war (1898): (1.) Late Island and Fonualei Island, in the Tongan Group. (2.) White Island, on our own New Zealand coast; but workmen do not care to stay there now, owing to earthquake movement. (3.) The Kermadecs: schooners can load "off and on." (4.) Hunter or Fearn Island, about 180 miles south-west of Kandavu. Hundreds of tons of sulphur are there to be had, and it is fairly pure, but landing is difficult. (5.) There are sulphur islands in the New Hebrides Group, which may be worked from Vila. (6.) Tanna, of course, contains a lot of sulphur. Four miles back from the anchorage—Port Resolution, which was partly destroyed by late earthquakes, which I shall speak of directly—in the direction of the active cone of the volcano, there is a valley, and by prodding with a walking-

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* A different estimate this to Mr. A. W. Mackay's.

stick an excellent bed of pure sulphur will be found. Vila is on the Sandwich Island, New Hebrides, and many steamers call there now. The New Hebrides are under English and French protection. (7.) In the Loyalties there are sulphur deposits, belonging now to France. (8.) At Greet Harbour, New Britain, where Germany has a coaling station, there is a sulphur point. Sulphur has been found in this group at the foot of the Mother and Two Daughters Volcanoes. (9.) There are also sulphur deposits on the New Guinea coast. I mention these facts now in case sulphur should be in commercial demand. It could form an adjunct to our New Zealand trade. I supplied what information I could upon this point a few years since to some English sulphur-miners, who wanted to dig and refine the deposits of ore in the Pacific. There is also a good deal of sulphur-ore to be obtained in our own hot-lakes district in New Zealand, some friends of mine in Auckland—the Messrs. Nathan—sending down some hundreds of tons of it to the port.

The Island of Niu-afu lies in 15° 34′ south latitude, 175° 40′ 40″ west longitude, and belongs to Tonga. Mr. Tarvis, one of our good English colonists in the Pacific, informed me that he resided on the island at the time of the eruption—about August, 1886. (The great eruption at Tarawera, New Zealand, was in June of that year.) About 7 p.m. the earthquake began by gently swaying the island, and continued until 12 p.m., to the fright of all the inhabitants—some seven hundred people—who aimlessly wandered about, carrying the old and feeble to the highest land for safety. At 12 p.m. occurred a tremendous report like the discharge of a 60-ton gun, and a great rocket ascended from the lake to a distance of some 800 to 1,000 yards. The shaking of the island then ceased. From the spot where the rocket ascended an active volcano formed, and continued for seventeen days, throwing up sand, stones, and water. The cocoanut-trees were all ruined by the water and sand, which, falling steadily, and cementing on the leaves, broke them down by the mere accumulation of weight. In different parts of the island the deposit from the volcano averaged 2 ft. to 20 ft., crushing everything beneath it. During the eruption lightning was constantly playing around the island, darting occasionally into the groves of cocoanuts, and smashing down the trees.

I gathered from Mr. Tarvis, as well as I can remember, that Niu-afu is an island of about thirty miles in circumference, the water of the inner lake being of a mineral nature, and some four or five miles across. The Admiralty instructions only make Niu-afu, or Good Hope, Island three miles and a half north to south and three miles east to west; about 500 ft. to 600 ft. high, and well wooded to the summit. The centre of

the island—an old crater—is filled with brackish water, in which are hot springs. A severe eruption took place in 1853—not so long before the great earthquake in Wellington in 1854—when a village was destroyed, and many lives were lost. On the 12th April, 1867, another eruption occurred, but without loss of life. This last outbreak was on the south end of the island. I am as particular as I can be about dates, as I wish to point out to members that our great New Zealand volcanic eruptions approximate somewhat in date to those of Tonga.

I had only the pleasure of one conversation with Mr. Tarvis, and somewhat hurried at that, as he was returning to his schooner; but I immediately jotted down in my notebook, as well as I could remember, the tenor of what he told me—I remember now he stated that the new crater formed immediately in the centre of the inner lake, where it soon reared itself a little cone of 50 ft. or 60 ft. in height. This outbreak of 1886 and the 1853 outbreak—making, of course, due allowance for the guesswork as to exact dates—approach so closely to our Tarawera eruption of 1886 and the great Wellington earth-movement of 1853–54 that I think I am justified in concluding that the whole line of activity to which I am referring is in some manner influenced by the same seismic phenomena. (It has been stated that when Mount Hecla, in Iceland, is in eruption Vesuvius is quiescent, and when Etna or Vesuvius is in eruption Hecla is quiescent; but I only make the statement for what it is worth, as I cannot vouch for it as fact.)

According to Mr. Tarvis, Niu-afu is famous for three things: (1.) Earthquakes. (2.) Growing the largest cocoanuts in the Pacific. (3.) The marau-bird, which lays an egg quite out of proportion to its size. This bird is about the size of a pigeon, and yet lays an egg as large as that of a goose. The egg hatches of itself in the sand, or if placed in a drawer or box where there is a certain amount of heat. The bird is only known in Niu-afu in the South Pacific. It appears to be peculiar to volcanic islands, where the sand is loose. The name of the island is spelt "Niue Foou," "Niua Foou," and "Niu-afu." Mr. Tarvis very kindly gave me two of the island's cocoanuts. I gave one to our Museum.

As I have said, the date of these disturbances it is necessary to remember—Tarawera, June, 1886; longitude 176° 25: Niu-afu, August, 1886; longitude 175° 40′: and Falcon Island (since October, 1885), 175° 20′. As I have also said, I can only vouch for the first date, as the other two I am not absolutely certain of. Within a few months we have evidence of an enormous eruption along this one parallel of longitude, the grandeur of which astonished all beholders. The distance from Niu-afu to Tarawera is close upon fifteen hundred

miles. As air, water and earth waves follow the same laws which are recognised by the theory of motion, I think I am justified in holding that these special volcanic manifestations were by some means connected.

A certain amount of confusion may arise in the minds of persons not acquainted with the exact pronunciation of names of places in the Pacific (the Tongese, for instance, pronounce each vowel), and I will explain more fully this name "Niu-afu." Mr. Tarvis, who resides there, spelt it to me as I write it. Angas spells it "Nuia Foou." The Admiralty sailing directions for the Central Pacific name it "Niu-afu," or Good Hope Island. Other writers spell it "Niu-fou."

The little island, as I have said, lies about thirty-five miles north and by west from Vavau. This name must not be confused with Nei-afo, or Neafu, the name of the grand harbour of the Island of Vavau itself; nor with Nine, which is the native name for Savage Island, an important island standing by itself to the eastward, containing some five thousand people.

Again, confusion arises from the very nomenclature of some of the islands. There is Fearn, or Hunter, Island, to the south-west of Kandavu, named, I expect, after Captain Fearn, of the "Hunter," who cruised in the Pacific in 1790 to 1798, and discovered another Hunter Island to the northward of Santa Cruz; and upon the map of the Pacific attached to this paper will be seen another Hunter Island to the north-west of Fiji; there are also some Hunter Isles in the Marshall Group: so that we have no less than five Hunter Islands, which must not be confused with each other.

It was stated to me by a lady in Tonga that one sharp earthquake shock occurred on the 8th October, 1894, about the time of a severe earthquake at the New Hebrides; also, that she remembered experiencing a sharp shock about the time of a late great earthquake in South America. If this observer's dates are correct—and they were given to me in perfect good faith—the position of Tonga would be an admirable one for a seismitic station.

No doubt the argument can be used that water may be always sinking through the earth's crust to the central heat, which, converting it into steam, throws it back again by means of the different safety-valves we call volcanoes. Furthermore, that, as the crust of the earth is always in movement, and contracting slightly by slickenside pressure, our supply of water will have farther and farther to go to seek the central heat; volcanic safety-valves may grow fewer in number, and the oceans eventually dry up. Volcanoes are therefore our best friends, for when they cease we may know

that this globe will not support human life, in consequence of the absence of surface-water, which has been absorbed by the planet itself. Even granite requires a certain amount of water to preserve its crystallization. I should therefore conclude that there is water still in the body of our moon, but no surface-water, and that the volcanoes there are all extinct.

The phenomena of the earth-wave attending earthquakes can perhaps be seen by the following simple experiment: Take a couple of milk-dishes; stand one inside the other, but separate the two with three small blocks of wood; pour into the top dish a bucket of milk, fresh from the cow; let it stand for a couple of hours, until the cream is fairly rising; then into the lower dish pour a bucket of boiling water: this will have the effect of altering the temperature of the milk, causing the cream to form into a skin on the top of the milk, and beneath this skin the imprisoned heat-waves in the milk will fairly exemplify the earth-waves during an earthquake. The cream-skin moves up and down as the imprisoned heat below endeavours to find vent, but it never moves lengthways. The circular motion of the ground in an earthquake, too, can be noticed in the cream-skin as the heat-bubbles rise through the milk. We can see—(1) The upward thrust; (2) the wave motion; (3) the side-to-side motion; and (4) the circular motion experienced during an earthquake fairly exemplified in this simple experiment. The rapidity with which the waves beneath the skin or crust move across the pan is only an instance of the velocity of motion, whether in light, heat, or sound. The wave travels under the sea just as readily as in the milk-pan, forming the tidal wave.

Mr. Napier Bell tells me that to account for the tidal wave he suspended a milk-pan, filled it with water, and then sharply struck the side. But this did not carry the wave as he expected. (If he tries heating the milk he will see the waves readily and quickly following each other.) The cream-skin, if as rigid as our earth's crust, would, I suppose, crack as the waves pass beneath it. Now, as all the great volcanoes are close to or in the sea, it is evident that sea-water pouring through the earth's crevices—of which there are many everywhere—reaching the central heat, is there converted into steam, which, becoming highly heated and imprisoned, seeks an outlet in waves along the crust of the earth, just as the heated milk moves beneath its cream-skin. I have noticed, also, that brine in which meat has been cured, after boiling, and when cooling, shows movements similar, I expect, to those observed in boiling-lava streams.

From Mounts Erebus and Terror in the Antarctic to Mount Hecla in Iceland, around and through the Pacific Ocean, and towards the Mediterranean and elsewhere, there

are, I think, a sufficient number of volcanic safety-valves—two hundred and seventy to three hundred—to keep our present supply of water upon the surface. The local Tongan earthquakes are therefore, no doubt, connected with the eruptions of Tofoa, which is a high flat-topped island nearly five miles in diameter, situated about fifteen miles to the westward of the Hapaai Group, 1,890 ft. high, and is a volcano in continual activity. But it may be—I do not say it is—that this particular group of islands is affected by distant earth-movements in Java and South America. We shall be able to judge better, after we establish seismitic stations in this most interesting position of the earth's volcanic energy, whether Tofoa acts in sympathetic connection with Java and Central and South America.

I, of course, ask to be excused for venturing to express any opinion, or to draw any conclusions in the course of this paper, upon the facts I have observed and collected. My simple duty is only in this paper to record those facts. But the subject is so interesting, and the field of observation so new, that it is difficult to refrain from drawing some conclusions. I shall therefore feel favoured by members correcting me when I err, as I have not had the time to study volcanology, and should like to be informed correctly concerning the facts I have noted.

Kao Island, lying two miles and a half north-north-east of Tofoa, is 3,030 ft. high, but not an active volcano. Captain Sir Everard Home, in H.M.S. "Calliope," who visited the Friendly Islands in 1852, reported that a volcano, or the indications of one, had been perceived about half-way between the Islands of Kao and Lette; and about twelve months previously smoke had been seen issuing from the surface of the sea. This date approaches somewhat the great earthquakes in Wellington.

Returning for a moment to Metis and Lette, I might mention that an island of volcanic origin, about 200 yards long and 110 ft. high, situated in latitude 19° 11′ S., longitude 174° 49′ W., was passed by H.M.S. "Sapphire" on the 16th April, 1878. It ejected quantities of white smoke, and appeared to be covered with sulphur. The island would seem to be identical with the rock, 29 ft. high, reported by the German ship "Metis" in 1875, the effects of volcanic action having probably added to its size. During my late trip I passed near this rock, and, as I have said, Mr. A. W. Mackay informed me that it was one mass of sulphur. The different estimates of height and size of this rock which I have given are interesting.

About six miles northward of Honga Tonga Island, which is two miles north-east of Honga Hapaai, lying to the north-

west of Tongatabu, there must be a submarine volcano, as smoke has been seen issuing from the sea. Then, Lette Island, in latitude 18° 50′ S., longitude 174° 37′ W., is high and volcanic, the peak being 1,790 ft. high. The large crater gives out a vaporous-looking smoke, and small jets issue from its side. This Lette Island is the same that Mr. Whitcombe referred to in his letter.

I will roughly give the longitude of those places already touched upon, in order that we may see at a glance the first line of volcanic action to which I desire to call attention in the Pacific Ocean: Mount Egmont, 174° E.; Tarawera, 176° 25′ E.; Tongariro, Ngauruhoe, and Ruapehu, 175° 48′ E.; White Island, 177° 12′ E.; Auckland, 174° 45′ E.; The Kermadecs, 178° W.; Pylstaart, 176° 7′ W.; Falcon Island, 176° 7′ W.; Lette, 174° 37′ W.; Metis Rock, 174° 49′ W.; Niu-afu, 175° 40′ W.: to which I may be allowed to add—Chatham Islands, 176° W.; Bounty and Antipodes Islands, 179° E.; Campbell Island, 169° E.; Auckland Island, 166° E.; Emerald Island, 163° E.; Macquarie Island, 159° E.; and Mounts Erebus and Terror, 178° 30′ E. (Other active volcanoes have just been discovered in Grahamsland, immediately to the south of Cape Horn. I only mention this here, but they form no part of this first line of activity, although they may be connected with it.)

Sir James Hector has referred, in his lectures to us about his late trip to these antarctic islands, to the gigantic nature of some of the remains of volcanoes upon them. I do not think them gigantic in comparison with the volcanoes of, say, the Sandwich Group. But I might ask geologists to consider whether the fact of so many of the earth's volcanoes being in or near deep water results from the sea-water finding its way, by various faults and crevices, through the earth's crust, reaching thereby the central heat, and immediately, at or near the fault or crevice, being thrown out again by volcanic vents even a thousand miles apart along the particular line of crevices immediately affected. If igneous rock can find its way up through the numerous fissures of the earth, surely water can easily find its way down to the central heat. I take it that the breadth of the line I am pointing out lies between the 165th parallel of east longitude and the 170th parallel of west longitude, or, rather, a slight diagonal or curved line across these parallels—south to north.

With respect to the numerous extinct volcanoes about Auckland, I should be glad if some member of the Institute residing in that locality would, before the road-contractors cart away these beautiful little cones to repair the roads—an act of perfect vandalism, I think, which the people of Auckland should at once put a stop to, as these little craters form

one of the most beautiful pieces of extinct volcanic scenery in the Southern Hemisphere—kindly furnish us with the compass bearings of the mouths of the different craters, in order that we may judge of the wind's direction at the time when they were in activity. In Fiji I think the low side of some of the craters faced the south-east, but I only write from memory. The highest side of a crater is always to leeward of the prevailing wind, owing to the dust and scoria being blown in that direction

Fiji and Samoa are clearly of volcanic origin, but in times so long past that it would be difficult to guess when they were thrown up from the sea. I noticed many extinct craters in Fiji and Samoa, but there are no active ones. There are, however, warm springs in a few places.

The three principal Tongan islands are low, being quite different to the towering majestic hills of the former groups. Tonga appears to me to be the result of one gentle upheaval; yet the Langiis in Tongatabu must have been built cœval with the ruins we find at Stonehenge, Brittany, Central America, and other places. Mr. A. W. Mackay kindly gave me two photographs of the trinolith there, which I lay before the meeting. I have always considered the stone images of Easter Island and the trinolith at Tonga came from almost the one and the same people, existing at the time of the pyramid-building age, four to five thousand years ago—a gentle, unwarlike, artistic race, submerged by successive barbarous Asiatic or Malayan colonising expeditions from Japan and Borneo. ("Viti" or "fiji" in Japanese means "a chain of hills"; Mount Fuji is its sacred mountain, I think.) Mr. Mackay promised to send me a paper containing a minute description of the Langiis, which I will lay before members as soon as I get it. The ruins at Ponape and Espiritu Santo, in the New Hebrides—and I think some will be found also in New Caledonia—may have dated from the same time, or they may be of a later construction—perhaps later.

Generally the ruins found in different islands in the Pacific will be found a subject of most interesting study. We find them at Tonga, Espiritu Santo (New Hebrides), Ponape, the Carolines, I think New Caledonia, Easter Island, and I am not certain whether there are not traces of the mound-builders to be met with in the Sandwich Group and Tahiti. It may have been that the Aztecs and Toltecs of Central America and the highly civilised ancient Peruvians sent out their colonising galleys westward into the Pacific four or five thousand years ago, and it is the ruins left by these colonies we find to-day; the Malayan and Negrettic populations we now find in the Pacific being of a later date, and having submerged the old

colonies, just as the Spaniards wiped out that same gentle race.

Neither the ruins at Ponape nor the Langiis at Tongatabu show much alteration in land-levels, so that those that support the theory of a great sunken continent in the Pacific will have to account for this absence of alteration during the past four to five thousand years. I am rather inclined to think, from the volcanic phenomena I am pointing out, that the tendency has been slight upheaval, together with subsidence. Nature appears to me to be so steady in all its physical phenomena that I can find nowhere evidences of great subsidence, or buckling, or even crumpling, in the earth's crust. There is a slight movement I admit, but so slight that it takes years and years for us even to notice it, such as the alteration in land—and I may be allowed to say sea—levels of the east and west coasts of the North and South American Continent. Directly there is too much subsidence, and the sea-water too readily finds its way to the central lava, immediately that portion of the globe becomes, as it were, a steam-boiler, and the crust is puffed out again into its proper shape, the extra steam escaping through or forming a near volcanic vent.

The whole of the central and eastern islands of the Pacific appear to me to be purely volcanic, for even what we name the "coral islands" are built up by the coral polyp from a volcanic base. What we call "atolls" are only the tops of extinct craters or volcanic hills, subsiding from the result of previous volcanic action. If built on the tops of craters, then the entrances should be in the direction of the prevailing wind, as that would be the lowest point of the crater (perhaps some of the captains of the Union Steamship Company would tell us whether this is so). But this rule would be subject to the varied work of the coral polyp. I only throw the suggestion out now for subsequent observation. The trend of the islands is certainly south-east and north-west, which also is, I think, the direction of the prevailing winds in the South Pacific.

In Samoa there are no permanently active present volcanoes. The group appears to lie almost outside the present line of active volcanic action; it is simply a cluster of extinct volcanoes. During the hurricane of the 26th March, 1883, all the vessels that were in Apia Harbour, except one small schooner, were driven out to sea and lost, this being attributed to a number of heavy waves, caused by earthquake. (To me it appears that the hurricane was the cause of the disaster, and not the earthquake.) Again, on the 12th September, 1866, dense masses of smoke arose from the sea near Tau Island and Orosenga (sometimes called Olusinga), and continued till the middle of November. The outbreak was pre-

ceded by repeated shocks of earthquake. It is not known whether a shoal has since been formed. The water was previously deep.

Earthquakes occur occasionally in Samoa, but have not caused much damage. On the 16th March, 1889, the great hurricane at Apia wrecked the German warships "Ebor," "Olga," "Adler," and "Nipsic," and the American ships "Trenton" and "Vadalia," Captain Kane, in H.M.S. "Calliope," steaming out in the teeth of the gale. No one attributed this misfortune to an earthquake.

I mention these matters now so as to warn our seamen to up-anchor and away from Apia whenever, in March, the weather looks threatening. Even in January I have experienced the tail end of a hurricane in Apia. January to March are dangerous months in the Pacific.

Aporima, or Apolima, a small volcanic island, and Savaii, rising 5,000 ft., contain many extinct craters.

In Fiji volcanic action has not entirely ceased, but there are no active craters. Violent earthquake shocks are sometimes felt, and at Wainunu and Na Saru Saru on Vanua Levu, and also on the Island of Ngau, there are boiling springs.

Rotumah (latitude 177° 10′ E.) is entirely volcanic, several exhausted craters being found there, but no trace of eruption for many years past; large and old trees growing and flourishing at the mouth of the principal crater. The surface of Rotumah is chiefly covered with scoria and ashes, among which lies a scanty but very productive soil.

The chains of the Ellice, Gilbert, and Marshall Islands, lying between the parallels of longitude included in my table —170° to 180° east longitude—look very volcanic in their origin. So does the semicircle of islands forming the Ladrone Group; also the trend of the islands south-east to north-west from and including the Sandwich Islands. It is much the same with the Caroline Islands, Paumotus, Society Islands, Cook and Austral Groups. The whole of these islands it will be noticed, including New Guinea, the Solomons, New Caledonia, and others, trend to the north-west; so do Java and Sumatra. Many of the atolls and sunken reefs awash trend also south-east to north-west. It is quite remarkable how constant this trending is all through the Pacific Islands.

On the other hand, Japan, the Kurile Islands, Kamchatka, and the Aleutian Islands trend to the north-east, as if in the original cooling of the planet the present ocean-bed of the Pacific set that way. It is as if internal volcanic energy expends itself in opposite directions like atmospheric storms in the Northern and Southern Hemispheres; or

perhaps I had better say as if internal volcanic energy, like the atmosphere, was and is subject to the diurnal revolution of the planet. I think I am justified in saying that it would be so in the original cooling of our earth's crust, and this quite apart from the great work performed by sedimentary deposit in forming the crust.

In a paper contributed to volume ix. of our Transactions I tabulated the formation of the various groups of islands in the Pacific as follows: Volcanic—Bonin Islands, Ladrones, Carolines, Sandwich, Marquesas, Society and Georgian, Cook, Samoan, Tonga, Fiji, New Hebrides, Banks, Santa Cruz, Solomons, New Ireland, and New Britain; coral—Marshall, Gilberts, Paumotus, Phœnix, Union, Loyalty, New Caledonia. But this tabulation was only a rough one, as I pointed out at the time that the Carolines, Cook, and Tonga Islands were of both volcanic and coral formation. Thus the hill at Neafu (Vavau, Tonga), called "Tolau" (from which visitors gaze upon one of the finest harbours in the Pacific, and as beautiful a scene as any one could wish to see), struck me as being formed by a volcanic blow of lava, which, disintegrating in the course of time, gives the present excellent chocolate-coloured soil around it. The coral, too, in the boat-cave at the entrance to the harbour, which visitors should see, is split in all directions by volcanic upheaval. (This cave is situated within a mile of Mariner's Cave, described by Byron.) The Island of Vavau is therefore both of coral and volcanic formation; indeed, all coral islands may be said to have a volcanic base.

A great number of the low coral islands in the Pacific have a lake in the centre, showing volcanic subsidence, or, rather, upheaval and subsidence, more than anything else. Nor is it very curious, seeing their origin, that these lakes should be composed of mineral water. The lake at White Island (New Zealand) is, I believe, hydrochloric acid. The whole Pacific bed is blistered with volcanoes.

I looked at the lake immediately at the back of Nukualofa (Tonga), and speculated as to the time when it was so formed—far anterior to the date of the Langiis. On the other hand, I have run aground upon an atoll, and wondered whether it was from the top of a crater that the coral polyp had begun its labour or a hill-top only of the supposed great sunken continent. There does not appear to be anything like the volcanic action in the equatorial belts of the Atlantic or Indian Oceans that we find in the Pacific, or we should have far more numerous islands in those oceans; so that, when considering geological questions in the Pacific, we are bound to take into account the terrific volcanic agency always at work. True, there are extinct volcanoes and lava-beds in

England, Scotland, Wales, France, and elsewhere, and basalt columns at Fingal's Cave, in Ireland. (Why basalt-like starch should form into columns is another physical law. which we know little about. From my point of view, however, these laws rule, and are governed by a living, as it were, vital energy which I have in previous papers been trying to describe, although, perhaps, not very successfully.)

But terrible as this agency appears to us, nevertheless it has been gentle in its constructive action—throwing the land up step by step and terrace by terrace; aiding the work of the coral insect here, and slowly lowering their gigantic breakwaters there; building huge mountains by the gradual deposit of lava and ash from below the sea-level to a height of 3,000 ft., 10,000 ft., and even 14,000 ft. above it; floating billions of tons of pumice over the sea and millions of tons of dust through the air; slowly bulging the reefs and islands outwards a few feet at a time, or washing those reefs and islands away by tidal waves and strong sea-currents. But, on the whole, the work has been gentle and comparatively harmless to human life; for what is even a couple of hundred feet of upheaval at the outside of any one spot—which our records give—in comparison with the geographical extent of the Pacific Ocean itself? Moreover, what is going on now has always been going on. The natives reside in perfect security beneath the active volcanoes, and cook their food in the thermal springs.

When I come to my third line of volcanic upheaval it will be noticed how constant a suggested 200 ft. upheaval appears west to east, as if volcanic energy, no longer meeting with the weight of the ocean waters, expends itself 200 ft. at the outside into the atmosphere. For, although Mauna Kea, in Hawaii, towers up some 13,805 ft. above ocean-level, and sinks down 18,000 ft. beneath the sea (3,023 fathoms) at forty-three miles' distance from the shore—a far greater total height than any mountain-range we find upon land—yet, so far as we know, the whole of this mountain has been formed by the deposit of volcanic lava, ash, and *débris*, showing what a true safety-valve it has been for untold centuries of time. (From this cinder-heap to San Francisco soundings show a level sea-bottom upon which a railway-line could be laid as upon a billiard-table.)

To any one, too, unacquainted with the great height of the mountains of Hawaii this island might appear of a comparatively small elevation, for its surface rises gradually from the sea fairly uniform; so that even the terrific energy here displayed has formed only a gentle-looking mound 150 miles in diameter at the base and 32,000 ft. in height, whose pleasant glades supply for mankind some of the most beau-

tiful home-spots in the world. It was through one of these pleasant grassy homesteads in 1868 that the imprisoned lava burst forth "in four huge fountains, 500 ft. to 1,000 ft. in height, forming a river 200 ft. to 800 ft. broad." Any segment of the circle formed by this huge crater would, I think, more than include any segment seen by Sir James Hector in his late trip to the islands south of this colony.

I might be allowed to digress here for a moment to call the attention of our engineers to the excellent work of the coral polyp in constructing harbours and breakwaters. There is a reef stretching away from New Caledonia for some hundreds of miles in length; and the reef fringing the Australian Continent to the eastward is some two thousand miles in length. Would it not be possible for us to imitate the work of nature's little polyp engineers, and, with a solution of lime, build away slowly and steadily, bit by bit (not monolith by monolith, as is being done in Napier), and so gradually expose a rugged broken wall to the sea, exactly similar to any of the fringing reefs of the Pacific islands? I must say that to my mind a smooth faced and topped monolithic breakwater is absolutely contrary to nature's breakwaters I have seen on every side in the Pacific. The rugged coral breaks up the water, as the huge rollers dash themselves harmlessly on the sea reefs; and on the shore reefs, the branching tree-coral, there built up from slender stems, even the shore surf fails to dislodge, so long as the live polyp inhabits its slender and often most delicate branches. The Napier Breakwater, as at present constructed, to my mind, is therefore quite opposed to nature's teaching. If the engineer-in-charge would take a trip to the Pacific islands he would see breakwaters of stupendous dimensions round almost every island, constructed in the very teeth of the waves, and so simply that his huge monoliths would appear barbarous and quite out of place. Nor do I know of any coral breakwaters constructed at right angles to the coast-line, as in Napier. Nature always builds her breakwaters a mile more or less from the shore, and parallel with it, leaving beautifully still water between the reef and the shore.

The Ellice, Gilberts, and Marshall Islands are all low coral-islands, earthquakes being occasionally experienced in the Gilberts from a south-west direction. Pleasant Island, in the Gilberts, is about 100 ft. high, having apparently been raised by volcanic action (latitude 0° 32′ S., longitude 166° 55′ E.). Along this first line, from Auckland to the equator, or perhaps I had better say as a general rule in the Pacific, the south-east trade winds blow steadily from May to November. During the remainder of the year the trade winds are frequently interrupted by northerly and westerly winds. A hurricane

occurs at any time between December and April. It must be noted, too, that great submarine volcanic movements do occur in this vast ocean no observations of which are made or records kept, and, as I have said, the observations made are very conflicting. Sometimes the pumice-stone reaches the surface, and for days vessels have sailed through a sea of it. But more often, in the great depths, the outthrow remains where it has been ejected, and is but slightly affected by ocean currents. From one view of this intricate question a volcano is really a delicate spring-balance. The boiling lava in the great crater of Mauna Loa, at the Sandwich Islands, is kept at its balance by so much sea-water finding its way beneath the earth's solid crust by some crevice within a radius of perhaps five hundred miles, more or less. An extra quantity of water pouring in produces a lava overflow. If the whole ocean-bed upon which the Sandwich Islands stand for a radius of, say, five hundred miles gently crumpled or subsided I do not think the eruptions would be so sudden. Still it will be noted that the lava flowed in 1855 for thirteen months. But even this is too short a period for the subsidence theory as being the cause of volcanic action. Nor do land-levels on the sea-line at the Sandwich Islands show subsidence—at least, I have not heard or read of such. These should show if subsidence was the cause of the many lava outflows there.

My task in this paper, I know, is to record the volcanic phenomena of the Pacific. But it is evident that water pouring in beneath the earth's crust—say, within a thousand miles of the right or left of the 180th parallel of longitude—and being immediately converted into steam, might tend to cause volcanic eruptions, and outputs of purely local lava, ash, or cinder at different rents right along that parallel south of the equator; or the water might pour in immediately at the foot of each particular volcano, which itself has formed the crevices simply by upheaval. (I ask to be allowed to draw a distinction between a fault and a crevice.) In our own great Tarawera eruption of 1886 a small lake disappeared, I think, immediately before the eruption. In the vast region of the earth's surface now under consideration it may be that earthquakes breed earthquakes and volcanoes multiply volcanoes, for it is evident that the more the earth's crust is broken upwards the more readily will the sea-water find entrance through the faults and crevices. On the great continents the absence of active volcanoes may be accounted for by the fact that only rain-water falls upon their surface, and that this supply is not sufficient at any one fault or crevice to set up thermal energy. Be this as it may, the fact of Mount Erebus, Tarawera, Falcon Island, and Metis throwing out somewhat

different ash and lava is no reason why the whole line should not be affected by one great internal cause. It has been said that an earthquake is only an incompleted volcano, but my view of the matter is slightly different. Shrinkage of the earth's crust (if shrinkage is still going on) would no doubt tend to close up all crevices, and so keep our seas upon the surface; but, nevertheless, the argument is justifiable that volcanoes are delicate steam spring-balances set in or near great water regions only.

SECOND LINE OF ACTIVITY.

Having said all I wish now to say concerning the first line of volcanic action in the Pacific, running from Mounts Erebus and Terror in latitude 72° S. to the equator on both sides of the 180th parallel of longitude, I will now proceed to the second line of activity, running from, let us say, Hunter Island, near Fiji, to the northern coast of New Guinea. Further than that I do not wish to go, as the doing so would take me into the volcanic phenomena of the Malay Archipelago, which requires a separate paper, and about which I know very little. The almost total absence of volcanic phenomena on the Australian Continent justifies me, I think, in drawing attention to the two lines I have sketched upon the map.

A glance at a map will show what I mean—viz., the line of present activity running from Fearn or Hunter Island on to the New Hebrides, Banks, Santa Cruz, Solomons, New Ireland, New Britain, the Louisade, Admiralty Islands, and New Guinea. New Caledonia, with Australia, appears to be outside this line, as earthquake shocks are very infrequent in both places. I am, however, not well acquainted with the phenomena in New Caledonia, but I hope shortly to pay a visit to that group.

This second, or north-western, line from Hunter Island forms, perhaps, a portion of, and the first or northern line bounding the 180th parallel of longitude evidently joins, a great crevasse belt, as it were, of weakness in the earth's crust, running east from Java to Central and South America, although, of course, I only hazard such a statement for the guidance of other observers. It is, I think, the widest stretch of ocean we have. It has been observed in other parts of the earth that craters in close proximity to each other do not throw out the same substances, but lava and ash from different strata, showing independent local action. But I take it that great thermal action when escaping would only melt the different local strata through which it passes, and yet the steam-force—say, by the incursion of water—be connected beneath the earth's crust. Earthquake phenomena would therefore have to be most carefully collected from the vast

number of islands lying between Tonga and Central and South America before we could venture to affirm that any direct line of weakness existed between Java and South America *viâ* Tonga; for, although the great Lisbon earthquake of 1755 was felt across the Atlantic, we know of no line of weakness in that direction, except, of course, in the Azores and Canaries. That earthquake was, as it were, a crust disturbance or wave over 700,000 miles of surface. So that lines of volcanic earth rents or fractures may be purely local, yet subject to sympathetic influence from distant disturbances. The question is, Are they so subject? Another matter is whether a number of seismometic stations established along these three lines I speak of in the Pacific Islands would afford proof of subterranean connection. Perhaps the table of dates I propose to submit at a future date may be of some use in determining this question.

Fearn or Hunter Island lies about 180 miles south-west of Kandavu (Fiji), in longitude 172° 5′ E., latitude 22° 24′ S. It is a volcanic block, about 974 ft. high, half a mile long, and about one-third of a mile broad. It contains, so I am informed, hundreds of tons of sulphur: jets of sulphurous vapours constantly issue from it. There is anchorage there for a 300-ton or 400-ton vessel. From the Wellington *Evening Post* shipping news of the 30th December, 1895, I take the following extract:—

"Hunter Island, one of those solitary but slumbering connecting-links of the great volcanic system that stretches from New Zealand right up to the East Indies, has, after three score years of apparent quietude, again burst forth, and given vent to the terrific subterranean forces that of late years have manifested themselves at similarly situated spots in the South Pacific. The captain of the American barque 'Seminole,' which lately arrived at Sydney from the Pacific Slope, reports, according to the *Sydney News*, passing the island in question on the 24th November and witnessing a magnificent spectacle. From two craters on the east side of the island, which at times was enveloped in sulphurous smoke and *débris*, large streams of lava poured down its mountainous side. The 'Seminole' passed within a mile and a half of the spot, but no trace of life could be seen. Hunter Island, however, has never been inhabited within the knowledge of man. It was discovered nearly a century ago, and is situated nearly midway between Norfolk Island and Fiji. At all times for the past ninety years thin smoke has ascended from the various points along its monotonously savage-looking sides. As long ago as 1835 the island burst out and shot forth a huge pillar of flame and molten lava, which ran down its side hissing to the sea. Since then, however, its hidden forces appear to have lain dormant."

Next we come to the New Hebrides. I first attach a description of what happened at Ambrym lately, as it is well to preserve it:—

"Some of the officers of H.M.S. 'Dart' ascended the volcano on Ambrym Island. The crater is a mile wide and 1,000 ft. deep. The stream of lava extends to Dip Point, and a column of steam rises to a height of 4,000 ft. A violent submarine disturbance has been experienced, smoke and fire rising near the south of the mission station. Frequent earthquakes are felt, and the sea as far as Mallicollo Island is covered with dust. Six natives have been killed by falling stones."

"Further details of the eruption at Ambrym, in the New Hebrides, show that it was one of the most remarkable disturbances recorded in the South Seas. As the flow of molten lava came on, filling up the valleys in its course towards the sea, the rush and roar became louder and louder, and every now and then, midst the dense smoke caused by the lava setting fire to everything inflammable, would arise a volume of steam as it rushed into the streams. The lava travelled several miles before reaching the sea. It completely swept a cliff away for a width of 30 yards, and poured into the ocean with a tremendous roar and hissing noise. When the glowing mass touched the water an immense volume of steam arose to a height which the officers of H.M.S. 'Dart' measured as 4,000 ft., and the sea boiled furiously, so that the man-of-war had to move out of reach. A continual fall of volcanic dust and other *débris* is still going on, and is completely covering everything. It is feared the natives will be reduced to starvation by the destruction of the crops. Should the fall continue much longer, all the vegetation will be killed from its effects. During the night shock after shock of earthquake occurred, some very violent, causing a sickly sensation amongst the 'Dart's' crew. From Port Sandwich, twelve miles distant, Ambrym looks like an island covered with snow. When the eruption began the natives were terror-stricken, men, women, and children fleeing for their lives."

"Admiral Bowden-Smith has received the following details of the eruption at the New Hebrides Group from the commander of H.M.S. 'Dart': On the 16th October, 1894 [he writes], whilst lying at Dip Point, Ambrym Island, an eruption on that island took place. On weighing anchor at 6 a.m. and proceeding to the eastward to resume surveying work, a remarkable heavy mass of cloud was seen rising over the centre of the island, and, on clearing the point, dense columns of smoke were seen descending from just the other side of the low coastal range. It presently became evident

that a lava stream, marked by dense columns of smoke, was making its way through the hills to the sea. The ship was stopped some 300 yards off the shore, where it was seen that the stream would emerge, and at 8 a.m. bursts of flames were seen rising among the trees, and presently the head of the stream appeared, a red-hot molten mass, with lumps of slag tossing about on the surface. When it reached the water a most magnificent sight ensued. A dense pillar of steam rose rapidly in a perpendicular direction to a height which was afterwards found to be 4,500 ft. A few seconds later violent submarine explosions of steam took place, the water rising in huge bubbles some 100 ft. high, and then bursting in all directions in radiating tongues of water with black masses of presumably lava. A considerable swell was set up outwards, and, as the area of explosions appeared to be extending rapidly, the ship was moved to a safer distance. Canoes full of natives were leaving the island in all directions, some of which were taken in tow to Dip Point, where they were clear of immediate danger. The ship then proceeded round to the south side of the island, when it was seen that the old crater at Mount Marum, in the centre of the island, was in violent eruption, and then dense masses of smoke were rising over the western end of the island. On returning, whilst rounding Dip Point, a sudden outburst, accompanied by continued violent explosions, took place. About two miles to the southward of the mission station the cliffs were seen to be falling in landslips, and, when anchoring, flames appeared over the crest of the gap behind the mission. The natives were assembled in terrified groups on the beach, and I accordingly sent the boats in, offering to take off all that wished. The group was in a state of tremor, and the noise of the eruption indescribable. Dust and *débris* from the burning bush fell continuously. We embarked over eighty men, women, and children, for the most part belonging to Dr. Lamb's mission, and proceeded with them to Rannon, near the north-east point of the island, a place of comparative safety. Through the next day the earthquake shocks were so severe as to cause the resident trader, Mr. Rossi, a Frenchman, to remove to Port Sandwich with all his natives and belongings. The natives brought from Dip Point were comfortably housed in a schoolhouse belonging to Dr. Lamb. The next morning (17th October) we proceeded to the north-east point of the island as far as Dip Point, which was found to be in inky darkness, objects scarcely visible over a quarter of a mile. Communicated with the shore, and found the natives reassured, as the actual fires had ceased. At 6 p.m. we proceeded to Port Sandwich, not clearing the shower of dust till more than half-way across. Several shocks were experienced

on the way, and at night thirty-one shocks were distinctly felt in seven hours forty minutes on board the ship, one at half-past 2 a.m. being particularly severe. At 7 a.m. on the 18th October we returned to Ambrym, dust still falling. A great portion of the cliff at Dip Point had fallen in the sea, and all along the shore to the eastward continuous clouds of dust were rising, and landslips occurred. We anchored at Rannon on the 20th October, and re-embarked all the natives, and landed them at Dip Point, all present danger being removed. Dust was falling heavier than ever, but of a lighter colour and finer description. Everything on shore was covered with a deposit of from ½ in. to ¾ in., the landscape being of one uniform dull slate-colour, and the ship was shortly a grey mass. Landed and proceeded over the hills until the lava stream was reached. Although cooled down, it was still proceeding at some 4 ft. or 5 ft. an hour in the direction of Banlag, on the south-east. Owing, however, to the thickness of the atmosphere, it was impossible to get any views of what was happening. Proceeded at 3 p.m. to Port Sandwich."

Port Sandwich must not be confused with Sandwich Island, or Vate, in the New Hebrides, as Ambrym Island is only twelve miles from Port Sandwich.

I might here refer to the Rev. A. W. Murray's visit to Ambrym, in the "John Williams," in September, 1861. He says, "There is an active volcano in the interior of the island, with the smoke of which the mountains in the neighbourhood are more or less enveloped. We were afterwards told by traders that the volcano is not on the island itself, but on a small island close to it—so close that seen from the opposite side it seemed part of the mainland."

Tanna is 320 miles south of Ambrym, showing the wide range of volcanic action in this one remarkable group.

The order of the most important islands in the New Hebrides Group, south to north, is as follows: Aneiteum, Tanna (containing Port Resolution), and Futuna, then Erromango, Sandwich Island (containing Vila Harbour and Havannah Harbour), Api, Mallicollo (containing Sandwich Harbour), Ambrym, Pentecost or Whitsuntide Island, St. Bartholomew, Espiritu Santo, Lepers, and Aurora Island.

Having taken Ambrym first, I will finish it. Ambrym Island really occupies a position north of centre in the group (latitude 16° 20′ S., longitude 168° 17′ E.). The island rises abruptly from the sea, extending some seventeen miles north and south by twenty-two miles east and west. Its hills are densely covered with vegetation. The height of Mount Marum, which is generally an active volcano, is 3,500 ft., and of Mount Tuiyo, on the northern end of the island,

3,100 ft. As seen from the north-west the latter has a beautiful and imposing appearance, from its symmetrical shape and the luxuriant vegetation on its lower slopes. The volcano on Mount Marum has no visible cone, but apparently an enormous crater. It occupies the centre of the island, standing in the middle of vast rugged fields of lava hitherto unapproachable. Round the main mass of the volcano are numerous recent cones no longer active, and covered with forest. In 1888 this volcano was unusually active, and in the following year three new craters were reported to exist in the centre of the island, and numerous jets of smoke were observed on the eastern coast and at Dip Point. It may be that volcanic activity has been greater than ordinary during the past twenty-five years. Visitors from America and Europe desirous of seeing some of these remarkable volcanoes should time their departure for New Zealand so as to arrive here about April or May. The hurricane season is then over, and also the hot summer months. The Union Company's steamers would carry them on to the different groups of islands, or tranship them to other steamers. Dip Point is on the west side of Ambrym, and rises abruptly from a small sandy beach to a height of about 200 ft. It appears to be formed of compressed volcanic sand and ashes in layers. A few miles south-east of Dip Point, in Belbin Bay, there are some hot springs. Black sand is usually found all round these islands.

Next, as to Tanna. This is what Captain Cook says of this volcano (his visit occurred in 1774):—

"Having found that the light we had seen in the night was occasioned by a volcano, which we observed to throw up vast quantities of fire and smoke, with a rumbling noise heard at a distance, we now made sail for the island, and presently after discovered a small inlet, which had the appearance of being a good harbour. The volcano, which was about four miles to the west of us, vomited up vast quantities of fire and smoke; and the flames were seen during the night to rise above the hill which lay between us and it. At every eruption it made a long rumbling noise like that of thunder, or the blowing-up of large mines. A heavy shower of rain, which fell at this time, seemed to increase it; and, the wind blowing from the same quarter, the air was loaded with its ashes, which fell so thick that everything was covered with the dust. It was a kind of fine sand or stone, ground or burnt to powder, and was exceedingly troublesome to the eyes. During the whole of the 11th the volcano was exceedingly troublesome and made a terrible noise, throwing up prodigious columns of fire and smoke at each explosion, which happened at every three or four minutes; and at one time great stones were seen high in the air. Forster and his party went up the hill on

the west side of the harbour, where he found three places from whence smoke of a sulphurous smell issued through cracks or fissures in the earth. The ground about these was exceedingly hot and parched or burnt, and they seemed to keep pace with the volcano, for at every explosion of the latter the quantity of smoke or steam in these was greatly increased, and forced out so as to rise in small columns, which we saw from the ship, and had taken for common fires made by the natives. A thermometer placed in a little hole made in one of them rose from 80°—at which it stood in the open air—to 170°. Several other parts of the hill emitted smoke or steam all the day, and the volcano was unusually furious, insomuch that the air was loaded with its ashes. The rain which fell at this time was a compound of water, sand, and earth; so that it properly might be called showers of mire. Whichever way the wind was, we were plagued with the ashes; unless it blew very strong indeed from the opposite direction."

The longitude of Tanna is 169° 20′ E., and the latitude 19° 30′ S. In August, 1840, the Rev. J. Turner visited the New Hebrides, but was driven away by the natives. That missionary shortly afterwards sent a report to the directors of the London Missionary Society, which contains the following reference:—

"Port Resolution (named by Cook after his own vessel), or Nea, Tanna, opens to the north, and is formed by a neck of low land on the east side, abounding in pumice-stone and other volcanic matter, and on the west by a mountain 500 ft. above the level of the sea. The interior of the mountain is a vast furnace, and in some places the crust is so thin that on passing over it it is like walking on a hot iron plate. Near the top of this mountain there is a barren spot, with fissures here and there, from which volumes of steam burst up now and then, and also sulphurous vapours. The greater part of the mountain, however, is covered with vegetation, and is inhabited by a population of some five hundred people, scattered about in several villages. They have not the slightest apprehension of danger, and have their settlements so arranged as to throw some of the hot places into their Marum, or forum, for public meetings, in the very centre of the village There they lounge and enjoy themselves, on a cold day, from the underground heat, and there, too, they have their night dances. Around the base of this mountain, and among the rocks on the west side of the harbour, there are several hot springs, which are of great service to the natives. Their degrees of heat vary. Some form a pleasant tepid bath, and to these the sick resort, especially those suffering from ulcerous sores. Some rise to 190°, and others bubble up about the boiling-

point. Every day you may see the women there cooking their yams and other vegetables, in hollow places dug out, and which form a series of never-failing boiling-pots. The men and boys have only to stand on the rocks, spear their fish, and pitch them into the hot spring.* Beyond this mountain, and about five miles from the anchorage, stands the cone of the volcano. The black sandy dust and cinders from the crater form a barren valley about a mile wide all round the base of the mountain which forms the crater. In crossing the valley one day we felt our walking-sticks going down among something soft, and, on looking round, found it to be a beautiful bed of sulphur, yellow as gold. Not far from the same place the fumes of sulphur were so strong from some fissures that we could not go near them. Near the base of the mountain we found some masses of a clayey substance, hard and in some places burning hot. From cracks here and there the steam and boiling water came up as from an immense boiler. But what most astonished us at this place was a steady drop, drop, dropping of water, quite cold, and clear as crystal, from a fissure within a few feet of another crack which was sending forth a blast of air so hot that we could not bear the hand near it for two seconds. It is the same at the hot springs already referred to. You can boil yams at one place. and within 5 yards of it get a glass of cool fresh water. The ascent up the mountain to the edge of the cup is a gradual slope, but the walking is laborious, as you sink to the ankles at every step in the fine dark-grey dust or sand which has accumulated from the eruptions of the volcano. The perpendicular height of the crater from the valley at its base is almost 300 ft. When you reach the edge of the cup you see that it is oblong and curved rather than circular, and about a mile and a half in circumference. On reaching the top and looking over the edge you expect to see the boiling lava, but instead of that the great cup contains five other smaller cups or outlets, separated from each other by ridges of dark sand. To see the boiling lava you would require to go down inside the outer cup, and then up one of these interior ridges. Were it solid rock the attempt might be made, but from the fragile sandy appearance of these smaller ridges it seems as if it would be sure to slip, and down you go. Then, again, you never know the moment there is to be an eruption, nor do you know from which of the five outlets it is to come. I felt no

* We could almost fancy that Mr. Turner was writing upon the phenomena and the custom of the natives of our own hot-lakes district in New Zealand. So near to each other are the New Hebrides and New Zealand, so similar are the phenomena, that I think Mr. McKay must admit some connection in the line of volcanic strength.

inclination to risk the experiment, which would be something like examining the interior of the mouth of a cannon, not knowing the instant it might go off. You feel that you are far enough when you stand on the edge of the outer cup. The hissing, panting, blowing, and strange unearthly sounds from these great gulfs, as you look down and along, are fearful, and presently you are awe-struck with the thundering deafening roar of an eruption, which baffles description. The simultaneous bursting of a number of steam-engine boilers, or the explosion of a ton of gunpowder, or the united volley from a regiment or two of infantry and artillery might be something like it. Then up fly the great crimson flakes of liquid lava, which gradually blacken and consolidate, and descend. More solid blocks of stone fly up with these softer masses, and rise far above them to a height of 200 ft. and 300 ft. from the edge of the cup. The most of this matter falls right down again into the crater. It sometimes takes a slant, however, as you see from the masses of obsidian or volcanic glass and scoria all about, so that you require to have your wits about you, keep a look-out overhead, and be ready to 'stand from under.' Clouds of steam and thick black smoke also rise with every eruption. This smoke goes, of course, with the prevailing wind, and the atmosphere for miles in that direction is charged with the dark volcanic dust. The volcano was to the west of where we lived. The first day we had a westerly wind Mr. Nisbet and I were busy out-of-doors putting up the roof of our house. We felt a strange sensation about the eyes and nostrils, and could not imagine what it was which was gathering on our hands and arms. Presently we discovered that the clouds of black dust from the volcano were coming in our direction, and that the atmosphere was loaded with the finest dark-grey particles. Next morning every leaf and blade of grass was covered with a thin coating of something like the finest steel filings. Our people were in the habit of praying to their gods for a change of wind on such occasions, and that, we were told, was pretty much the case all over the island. Every one, when annoyed with the smoke and dust, prays that they may be sent elsewhere. At Port Resolution we seldom had a westerly wind, and, as it did not last above a day or two, we did not suffer much inconvenience from the volcano; but that dust must be very troublesome to settlements in a westerly direction. Captain Cook speaks of having been annoyed by this volcanic dust. He did not venture so far inland as to visit the volcano. The account, however, which he recorded of the frequency of the eruptions, and their appearance from the harbour, is interesting and useful, as it is an exact description of the working of the volcano at the present day. Speaking of the mountain on the west side of

the bay, to which we have referred, he thus wrote: 'Some of our gentlemen attempted to ascend a hill at some distance, with an intent of observing the volcano more distinctly, but they were obliged to retreat precipitately, the ground under them being so hot that they might as well have walked over an oven. The smell, too, of the air was intolerably sulphurous, which was occasioned by a smoke that issued from the fissures of the earth.' In another place he remarks, 'On Thursday, the 11th, during the night, the volcano was very troublesome, and threw out great quantities of fire and smoke, with a most tremendous noise; and sometimes we saw great stones thrown into the air. On the 12th the volcano was more furious than ever, and we were much molested with the ashes' ('Cook's Voyages,' folio edition, p. 168). Had we been longer on the island we might probably have paid a night visit to the volcano; but it was a fine sight to look over from our door, on a calm clear evening, to the brilliant display of fireworks, which went blazing up every eight or ten minutes. So far as we observed, that is the usual interval between the eruptions night and day. The native name of the volcano is Asur (Yasua). They have a tradition that it came from the neighbouring island of Aneiteum; and probably this may be founded on some fact, as the extinction of a volcano on Aneiteum being followed by the outbreak of this one on Tanna."

Aneiteum is certainly volcanic, and rises some 2,700 ft. above sea-level. It is only a few miles from Tanna. Earthquakes are frequent. On the 28th March, 1875, a severe shock was felt, accompanied by a seismic wave, since which date the volcano at Tanna has been unusually active. Aneiteum is the most southern island of the New Hebridean group. The kauri-pine grows here, as well as at Kandavu, in Fiji. This island is slightly nearer New Zealand than Kandavu. Aneiteum, Kandavu, and Auckland form what I may call the "triangle" of the kauri-pine; a problem I leave to botanists.

The Island of Futuna, to the east of Tanna, rises up out of the sea like a great square table some 2,000 ft. high. The missionary estimates of these heights are not exact. I regret to say that neither the heights of the mountains nor the circumferences of the islands in the early missionary accounts can be depended upon. They have often deceived me. Otherwise the accounts are excellent and most praiseworthy.

I wish to mention here that in May, 1845, Mr. Turner visited Lifu (Loyalty Islands, not so very far from Tanna), which he describes as "being probably eighty miles in circumference, an uplifted coral formation, and covered with pines in some places. The highest land on the island may be 300 ft. above the level of the sea." Of Mare he says, "Mare is a

smaller island than Lifu. It, too, is a mass of uplifted coral. There are marks of two distinct upheavings."

In July, 1848, Mr. Turner was again at Tanna, but he makes no mention of the activity of the volcano then.

In October, 1887, the volcano at Tanna (Mount Yasua) was unusually active, the eruptions being heard many miles distant, and the smoke and ash reaching to the Island of Erromango, lying to the north. About the same time an eruption resembling the explosion of a torpedo was seen in Sandwich Harbour, Mallicollo—320 miles away—where a severe shock of earthquake was also felt. (I have referred above to a somewhat similar explosion at Niu-afu, mentioned by Mr. Tarvis as having occurred in August, 1886. These explosions are merely the old plug of the crater being blown out, like a cannon ball, by the new explosion.)

Sandwich Harbour, in Mallicollo, must not be confused with Vila Harbour, in Sandwich Island, or Efate. Havannah Harbour is also in Efate, or Vate. This is the finest island, and the headquarters of trade in the group. Steamers regularly call now at Vila.

The more southern islands of this group rise steeply from the sea to a height of 500 ft. to 1,000 ft., when in many cases there is a plateau, and again a rise of 500 ft. to 1,000 ft.

The volcano at Tanna has two distinct craters. It is destitute of vegetation, and is situated in the south-eastern part of the island, eight miles from Port Resolution. Its height was ascertained by the officers of H.M.S. "Pearl," with aneroid barometer, to be 980 ft., the crater being about 600 ft. in diameter and 300 ft. deep. During a part of the time of the "Pearl's" visit it was throwing up large masses of scoria to a height of 600 ft. There is a large lake, a mile in length, near the foot of the mountain. Port Resolution is situated at the eastern end of the island. On the 10th January and on the 11th February, 1878, earthquakes occurred here. Previous to the outbreaks the wind had been strong and variable, and the weather hot, with rain; the volcano throwing up huge rocks. Within the recollection of the natives no earthquake had occurred before. At the first earthquake a new volcano burst out close to Sulphur Bay, between it and the old volcano. A wave about 50 ft. high arose, swept the eastern point of the harbour, and destroyed the native plantations, vast numbers of fish being left in the bush by the receding water. About 100 yards of the bed or bottom of the harbour at the west side rose above the former sea-level.* At the second earthquake

* It will be remembered how, during the great earthquake of 1855 in Wellington, the bottom of the harbour was similarly raised about 4 ft. So that I may say volcanic upheaval keeps the crust of the earth fairly

another 300 yards of the bottom was thrown upward, making the entrance to the harbour very narrow. Across the harbour, a little inside the entrance, there is now a bar, with only 15 ft. of water, where formerly there was a depth of 5 to 5½ fathoms. In some places near the shore the bottom has been raised 20 ft., or even more, above the sea. The whole harbour is so contracted by the upheaval that it is doubtful if a large vessel could find room to swing in it. At about a cable seaward from the west point of the entrance three rocks have been thrown up in a position where formerly there was 11 fathoms (66 ft.) of water. A high hill near the rock named Cook's Pyramid, on the west side of the entrance, fell into the sea. This made a new point of land; and Cook's Pyramid has been raised about 40 ft. A patch of discoloured water, about a cable in extent—probably a shoal formed by the earthquakes—has since been seen about two miles north of the port. H.M.S. "Nelson," however, obtained a sounding of 116 fathoms nearly in this position. On the west side of the island the shock was scarcely felt, and there was no seismic wave. From information supplied by the British Consul at Noumea it appears that in August, 1878, about a fortnight after H.M. schooner "Renard" had completed a resurvey of Port Resolution, rendered necessary by these volcanic upheavals, another earthquake and extensive upheaval took place. Cook's Pyramid disappeared, its remains being made out with difficulty; and though the harbour has narrowed to about 200 yards, and the depth decreased considerably, there is still good anchorage for small vessels in it, and fairly good shelter from south-east winds for large vessels off the entrance. On the 28th March, 1875, an earthquake and seismic wave visited Dillon Bay, Erromango. The wave rolled large boulders of rock on to the beach, and altered the depth and direction of the entrance to the river, which has since silted up. The foreshore and most of the terraces of Erromango consist chiefly of coral limestone, showing considerable symptoms of upheaval, with here and there a black volcanic rock.

I should consider Mai, or Three Hills, Island, rising respectively 1,850 ft., 1,450 ft., and 1,400 ft., and Api (Tasiko) Island, with its three peaks, rising respectively 2,500 ft.,

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at its proper contour where there is danger of much subsidence. It appears to me to be a wonderful force most gently guided. That it is principally thermal can be seen from the regularity of the steam pulsations both in Captain Cook's and the Rev. Mr. Turner's accounts. So that the volcanoes we possess not only keep the oceans on the surface of the earth, but the crust of the earth itself "true to shape." I therefore cannot follow Sir R. S. Ball's argument of the absorption of the oceans by the planet in the short period he names.

2,800 ft., and 1,800 ft., formed by gradual volcanic action, and perhaps upheaval.

The Island of Lopevi, about three miles east of Paama, also contains an active volcano, occasionally throwing out burning ashes. It is a perfect cone, rising some 5,000 ft. out of the sea.

Lepers Island, or Omla, was so named probably in consequence of the prevalent skin-disease being mistaken for leprosy. It is about seventeen miles long, north-east and south-west. Its magnificent mountain, rising to a height of 4,000 ft., resembles a whale's back in outline, and from the sea assumes a most imposing appearance. On its summit is a small lake, from the centre of which rises a small crater that often emits smoke.

Port Sandwich, on Mallicollo Island, is said to be the only harbour in this group where a moderate-sized vessel could ride out a hurricane in safety. At Pentecost Island, and at numerous islands in the Pacific, beds of the streams often change suddenly and most remarkably after heavy rains. In 1873 I pulled my boat through living cocoanut-trees standing fairly deep in the water up Nandi River, in Fiji. That stream had just previously changed its bed. In Tonga, of course, there are no rivers or streams. I suppose the loose soil in all volcanic islands accounts for this sudden alteration.

Near Cape Cumberland, forming the north point of the great Island of Espiritu Santo—sixty-four miles long and thirty-four broad—"are to be seen the ruins of buildings of considerable size, pillars of regular shape and fragments of masonry scattered over a plain of about three miles in extent; and at a village five miles distant from the cape are similar remains, of which the natives appear profoundly ignorant." I mention these ruins as they may be useful in determining land-levels in this direction; but the ruins are doubtless only broken pillars of basalt.

Cape Quiros, the opposite horn of St. Philip's Bay, runs back in successive steps towards the central range of Espiritu Santo. These steps may doubtless give the height of the successive upheavals.

Generally, with regard to the north-west line I am now following through the Western Pacific, in the Admiralty sailing directions are the following remarks: "A great number of the islands are entirely of volcanic origin, many attaining a high elevation, and at the present time they include several active volcanoes. Lesson Island, off the north-east coast of New Guinea; the volcanoes in the north-eastern portion of New Britain and in the Duportail Islands; Bagana, in Bougainville Island, of the Solomon Group; Tinakula, in the Santa Cruz Group; and Tanna and Ambrym, in the

New Hebrides, have all been recently in eruption. As a consequence of this volcanic activity great fields of pumice have been seen by various navigators, covering large tracts of the Western Pacific to such an extent that ships have been occupied for days in sailing through them; and subsequent to the eruption in New Britain in 1878 fields of this material were floating about amongst the islands for many months, reaching as far to the eastward as the Ellice Group. Earthquakes are of frequent occurrence in the vicinity of New Britain and the Solomon Islands, though, as a rule, they are of moderate character; while in the southern islands of the New Hebrides Group they sometimes occur. Some slight shocks have been recently (1887) reported from the north-east coast of New Guinea, during which the atmosphere is described as being so thick as to give the appearance of dense rain. In 1878 severe shocks of earthquake were experienced over a large area. At Port Resolution, in the Island of Tanna, two shocks occurred, whereby the port as a harbour for large vessels was partially destroyed; and in the neighbourhood of Lord Howe Islands the barque 'Pacific Slope' reports having felt a shock on the 3rd March, the vessel at the same time being set by an unusual current 110 miles to the south-south-east."

I am much indebted to the Admiralty directions for many such extracts in this paper. I consider it well to collect them into one paper, add the remarks of other observers, and include my own observations, in order not only that we may have the whole of the most important earthquake volcanic phenomena of the Pacific before us in the one paper, but also that we may know where to establish seismic stations.

I hope in a future paper to give a list of dates as a record of what is happening at the present day.

With respect to Banks Islands and Santa Cruz, the Banks Islands are all of volcanic origin—Gana (Santa Maria Island), Vanua Levu, Ureparapara (Bligh Island), Valua (Saddle Island), Mota (Sugar-loaf Island), and Merlav (Star Peak Island). Mota and Merlav "rise straight up from considerable depths to well-defined symmetrical cones 1,350 ft. to 2,900 ft. high. Ureparapara is simply the unsubmerged portion of a large crater with the eastern face blown out, forming a fine harbour therein." Vanua Lava, Gana, and Ureparapara still exhibit signs of latent activity in the form of fumaroles and sulphur springs. Merlav has long been inactive as a volcano. Mota exhibits distinct signs of upheaval, the volcanic portion of the island resting on a base of madrepore (fossil coral). The summit of the volcanic range running through Vanua Levu frequently emits columns of steam. The sulphur springs, fumaroles, and solfataras are on the west side of the Gana

Lake, which is eighteen miles in circumference, with a black-sand bottom, and 400 ft. to 500 ft. above sea-level. Mota, as is well known, is the headquarters of the Melanesian Mission in the Banks Group. Volcanic heat is still felt on the western slope of the summit of the old crater at Ureparapara; extreme height, 2,440 ft.

The Santa Cruz Group lies to the north of the Banks Group, and consists of six larger islands, namely: Vanikoro (where La Perouse's crew were wrecked and massacred in 1788), Terai, Ndeni (Santa Cruz), Te Motu, Tinakula, Lord Howe* Island,† and the Swallow Group of smaller islands. (At Nukapu, in the Swallows, Bishop Patteson was killed in 1871; and Commodore Goodenough, whom I well remember, was killed at Carlisle Bay, in the Island of Santa Cruz, in 1875.) In both these groups—Santa Cruz and Banks—shoals and little islands appear and disappear from time to time, showing the wonderful volcanic agency at work.

Tinakula, or Volcano Island (Tamami), lies twenty-seven miles to the north-west of Ndeni Island, and is a volcanic cone rising to the height of 2,200 ft. The lower portion is covered with vegetation; the upper part is entirely barren. In 1871 H.M.S. "Rosario" observed a stream of lava flowing down the north-north-west side of the cone. Flames and smoke were also emitted at intervals of from ten to fifteen minutes. In 1886 H.M.S. "Opal" visited Tinakula, and the volcano was described as having recently been active.

With regard to the Solomons, "Some of these islands are entirely volcanic, whilst others are calcareous, but there are also many in which both formations are combined. Guadalcanar is volcanic (latitude 9° 45′ S., longitude 160° E.), and so is Saro. The volcanic character of Saro does not appear to be generally known. The last eruption seems to have occurred thirty-five or forty years since, when large quantities of water, dust, and ashes were ejected, and several natives killed. Although at the present time the volcanic forces are slumbering the natives are always apprehensive of an outbreak. Earthquakes are very frequent, and during one which occurred several years ago a subsidence of part of the coast took place, and vessels now anchor where there was a village. Buraku (Murray Island) is a volcanic island 1,000 ft. high; uninhabited. The Maroro Group (New Georgia) consists of three principal and innumerable small islands. The larger islands are of recent volcanic origin, and have numerous symmetrical cones (latitude 8° 50′ S., longitude 158° 13′ E.). Rendova

* As the Pacific becomes better known this reduplication of names should be done away with; it is very confusing.

† This island must not be confused with the Lord Howe Island off New South Wales.

Island is volcanic, rising 2,500 ft. In Vella Island many of the peaks contain dormant volcanoes. Narovo Island is about four miles long. With the exception of the adjacent Islet of Simlo, and the narrow neck, which are of upraised coral, the whole of this island is of volcanic formation, signs of activity being at present confined to the southern portion, which contains the more elevated land, and Middle Hill and South Hill, rising to a height of 1,000 ft. and 1,100 ft. respectively. On the south-west coast, at the foot of the north slope of the crater (South Hill), there is a salt-water lagoon which communicates with the sea on its north side. On the south shore of this lagoon is a boiling spring, and in the vicinity the water is hot for about 30 yards from the shore. The lagoon is frequented by crocodiles; proving its former connection with New Guinea, and perhaps Australia.

Fauro Island is volcanic, rising 1,925 ft. Bougainville, the largest of the Solomon Islands, is about 110 miles long and thirty broad. The southern part of this island is very mountainous, the summits ranging from 4,000 ft. to 10,000 ft. Amongst these are several volcanic cones, but only one—Bagona, in the centre of the island—is at present in a state of active eruption. This volcano forms a conspicuous object for passing vessels, being visible for more than fifty miles. At the back of Empress Augusta Bay, on the west side of the island, a volcano has been seen in full activity.

Of the isolated islands near the Solomons, as I have before remarked, the British barque "Pacific Slope" reported having experienced a shock caused by volcanic eruption in the neighbourhood of Lord Howe Islands on the 3rd March, 1878, and to have been set 110 miles south-south-east by an unusual current. A great quantity of pumice-stone was afterwards found floating around the ship.

With regard to New Britain, from a report contributed by the Rev. William Fletcher to the *Fiji Times* of January, 1876 (which I find in my scrap-book), of the manner in which the Wesleyan Mission was opened in the Duke of York, New Britain, and New Ireland groups of islands, in the schooner "Wesley," by the Rev. G. Brown and himself, during July and August of the previous year, I make the following extracts: "The islets about Duke of York Island are formed by coral upheaval. There are two lofty volcanic peaks (the Mother and Two Daughters) in New Britain (longitude 152° E.). Simpson Bay (New Britain) is a noble harbour, but the whole aspect of the hills surrounding it suggests terrible volcanic agency. As to these peaks—the Mother, 2,470 ft. high; the Northern Daughter, 1,866 ft.; and Southern Daughter, 1,727 ft. —the top of the last is a large bare crater, its volcanic fires so lately extinguished that vegetation has not had time to

clothe its sides. Some of the natives said that smoke still issued from the top; others that there was a lake at the bottom of the crater. At night there was a strong and offensive smell of sulphur. Earthquakes, accompanied with loud roarings and undulatory motions of the earth, are also said to be common. Henderson Island is composed of volcanic ash and gravel, and is of very recent formation (so the old men say), having been thrown up during an earthquake. On landing we found a late subsidence of the beach, and in one place we saw extensive landslips, caused by earthquake. There appeared to be few fringing reefs about the Solomon Islands, or in this locality. The great depth of water close to the islands and the scarcity of good anchorage we often noticed."

Besides what I have already quoted from the Rev. W. Fletcher's report, the Admiralty sailing directions give as follows: "The island (New Britain) generally is mountainous, and in the northern peninsula there is an active volcano, which was last in violent eruption in February, 1878. At that time an island—Volcano Island—60 ft. to 70 ft. in height was thrown up on the western shore of Blanche Bay. This eruption was succeeded by a seismic wave, which washed away a large portion of Matupi Island; and the whole of Blanche Bay and St. George Channel was covered with pumice. In the north-west portion of the island, south of the Gazelle Peninsula, and in the Duportail Islands, off this part of the coast, there are also active volcanoes."

Blanche Bay is overlooked by the three magnificent cones of the Mother and North and South Daughters, on Crater Peninsula, with the rugged outlines of the smaller volcanoes in the foreground. The Germans have established a coal and trading station at Greet Harbour, on this peninsula, between Sulphur and Bridges Point, so that I should think deposits of sulphur will be found there.

On the 13th March, 1888—not so very long before the great shock in the Amuri district, recorded by Mr. McKay in volume xxi. of our Transactions, to which I have already referred, and during the time the booming noises were being heard in that district—Greet Harbour "was visited by a seismic wave, reports of which have been received from other parts of the coast of New Britain, as well as from the north-east coast of New Guinea. At Matupi Island, fronting the harbour, the sea receded at times from 12 ft. to 15 ft. below the lowest water-mark, and then rose in several waves to the same height above high-water mark; but this phenomenon was chiefly confined to the north and south-east sides of the island. The waves came partly from the south and partly from west-north-west. No indications of earthquake were

noticed. The weather at the time was clear, with a gentle south-east breeze."

About one mile north of Bridges Point is a hot salt-water creek.

On the mainland of New Britain, abreast the Duportail Islands, are the North Son, Father, and South Son Mountains, which attain respectively heights of about 1,300 ft., 4,000 ft., and 3,000 ft. The former is apparently an extinct volcano; the two latter are still active.

Leaving New Britain, and travelling on further west and north, we come to Rook Island, of volcanic origin, the highest of whose mountain-peaks reaches 5,000 ft. Volcano Island, off the north-east point of Rook Island, is in latitude 5° 32′ S., longitude 148° 6′ E. Its form is that of a regular cone, broken at the summit, about 3,500 ft. high. In March, 1700, Dampier described this island as being in active eruption. Lottin Island—not far from Volcano Island—is also a volcanic cone, 5,200 ft. high, from which smoke issues from a large hollow on the north-east side. North Island is about thirty miles further north. In November, 1861, Captain Lass, of the brig "Wailua," discovered a singular shoal five miles north-west of it. The shoal is about half a mile wide and five miles long, in the form of a crescent. Captain Lass reported that on approaching the shoal an appearance was observed as of a whale spouting, which was found to be a boiling spring, emitting water to a height which he estimated at 150 ft. A boat was lowered, and a sounding of 10 ft. was obtained on the shoal.

About fifteen miles to the northward of North Island lies Gipps Island, a round sugar-loaf-shaped island about three miles in circumference. The island is thickly populated. There is a boiling spring on a sandy beach on the south-east side, and also one on the south-west side, which threw up water at times to a height of 20 ft.

Near the south-west end of the largest of the Duportail Islands, lying sixty miles to the eastward of New Britain, there is an active volcano.

With regard to the D'Entrecasteaux group of islands, at Seymour Bay, Ferguson Island, on the south-west coast, there are saline lakes and several small hills giving forth sulphur fumes, and there are also several boiling springs.

Germany having lately named the harbours and rivers upon the north coast of New Guinea differently from those upon the map, I can but refer now to the seismic phenomena I have gathered in that direction for subsequent verification.

Starting from Cape King William, passing Astrolabe Bay, and following the coast-line of New Guinea in a north-westerly direction, we come to Vulcan Island, of which I attach a

sketch taken from the *New Zealand Graphic* (Plate LI.). "Vulcan Island is considered to be one of the largest volcanoes in the Pacific, if not in the whole world." The crater of Kilaueanui (near Honolulu) is the largest crater we know of. Vulcan Island is in latitude 4° 5′ S., longitude 145° 2′ E., and is only about 4,000 ft. high, whereas Cotopaxi is 18,887 ft. The island is clothed with vegetation. Hecla, in Iceland, and Jan Meyen (70° 49′ N.) are also larger.

On the 13th March, 1888, Hatzfeldt Harbour was visited by a seismic wave, which also visited Cape King William and the coasts of New Britain. "Soon after 6 a.m. a noise like firing was heard to the north and north-east, and at 6.40 a wave, coming from the former direction, broke upon the shore at a height of 6½ ft. above high-water mark; it then receded with such violence that half the port was dry. About 8 a.m. the height of the wave was from 23 ft to 26 ft. The sea continued to rise and fall at intervals of three to four minutes until 9 a.m., when it began gradually to subside, and by 6 p.m. it had resumed its normal condition."

With respect to the sound caused by earth-movements, the sound waves of the Tarawera eruption in New Zealand on the 10th June, 1886, travelled a radius of a hundred and fifty miles—viz., beyond Auckland and Wellington—giving a whole diameter of three hundred miles. I heard the sound of the explosion near Wellington much like the distant muffled discharge of heavy ordnance. A booming sound usually precedes a sharp earth-shock. This is caused by the peculiar sonorosity which sound takes when confined in the earth. Drop a pin down a well, and, if it strikes the water flatly, the sound wave set up will be most sharp and distinct. It cannot be otherwise, seing that the sound waves, in place of spreading, are confined by the circumference of the well, and can only travel upwards. Now, if a pin will do this, what are we to expect from an earth-wave itself grinding and rending the solid earth strata?

When the great earthquake of Cosequina, in Nicaragua, took place, in 1835, the subterranean noise—the sonorous waves of the earth—was heard at a distance of a thousand miles; whilst in the eruptions of the volcano on the Island of St. Vincent, in 1812, at 2 a.m. a noise like the report of cannon was heard, without any sensible concussion of the earth, over a space of 160,000 geographical square miles. There have also been heard subterranean thunderings for two years without earthquakes. I think Mr. McKay told us that such rumblings were heard for a year previous to the late sharp earthquake on the Hanmer Plains. A friend informs me that the late Mr. Cooper, native interpreter, of Gladstone, Wairarapa, told him that he was sleeping

in a Native village near Tarawera on the night of the great eruption of 1886. Some three hours before the outbreak the whare suddenly swarmed with rats, and the natives were as surprised as himself at the invasion. No doubt the rats had heard the subterranean rumbling, and thought it advisable to get away from danger, for had they remained they would most certainly have been killed or buried. From this it has been proposed to foretell earthquakes by connecting telephones to the pipes of deep artesian wells and to metal plates sunk in deep mountain crevices. Any unusual noise in the bowels of the earth would be audible in the telephone, and would indicate trouble.

As I write, too—April, 1895—the volcano Cotopaxi, in Ecuador, is active, and the inhabitants of Quito are terror-stricken.

The whole of Southern Austria and Northern Italy, too, has just been—18th April, 1895—much shaken by thirty-one shocks of an extensive earthquake, many cities being panic-striken (Laylach, Venice, Trieste, &c.), and railways so twisted as to be unworkable. These shocks were accompanied by incessant roars of the most terrifying description. At a hundred and fifty miles distance such roars would, I think, somewhat resemble the discharge of cannon.

With respect to tidal waves, I wish to point out to the people inhabiting the islands of the Pacific the *recurrence* of the wave in Hatzfeldt Harbour, New Guinea, varying from 1 ft. above high-water mark to 25 ft.; also, the time of the disturbance—viz., twelve hours. As seismic phenomena are frequent in the Pacific, I should advise the people there to look as carefully as they can after their boats and shipping, and to remove themselves and their valuable belongings for twenty-four hours to high ground when any island is visited by what is called a tidal wave, as there is no trusting the damage such an unwelcome visitor may do. Water, when moving forward in a body—for waves do not usually move—has almost as much power as water falling in a body. It will toss upon its crest huge rocks of many tons weight, and tear up and level down almost any obstruction in its path. A tidal wave in an hour will do more damage to an island than a century of storm, hurricane, and rain.

At Victoria Bay, D'Urville Island (New Guinea)—not marked on the map—there is a salt thermal spring on the south side of the bay, the temperature of which approaches boiling-point.

Lesson Island, the southernmost of the Schouten Isle Group, is an active volcano, about 3,000 ft. high. Trees and grass reach almost to the top on the northern side; but on the southern side, nearly the whole distance to the base, the

island has a burnt red appearance, showing the devastation caused by a late eruption. Garnot Island, in the same group, is also a steep cone, but not so steep as Lesson Island; and Blosseville Island is a high, steep, wooded crater, remarkable for several large villages upon its edge. The natives evidently have far more confidence in the safety of these craters than I have.

As I write these notes—22nd March, 1895—a series of earthquakes are reported by telegram as having been felt at Port Moresby and other parts of New Guinea on the 6th and 7th of March last. The first shock lasted three minutes. No damage was done, but the natives were in great consternation. It is surmised that an extinct volcano on the island had opened up. On the 18th April, 1895, a telegram by way of Sydney states that a tidal wave in New Guinea has swept away many houses and drowned one child in a native village there. Both telegrams, I should think, refer to the one earth-movement. (I do not name volcanic phenomena "catastrophies," although I am very sorry when loss of life occurs, even to a little native child. I regard these earth-movements as absolutely essential to the welfare of the planet.)

ART. L.—*On the Artesian Wells at Longburn.*

By J. MARCHBANKS, A.M.I.C.E.

Communicated by Sir James Hector.

[*Read before the Wellington Philosophical Society, 4th March, 1899.*]

Plate LII.

THE well I have particularly to describe is an artesian pipe 2 in. in diameter recently put down by the Wellington and Manawatu Railway Company for the purpose of obtaining a supply of water for locomotive purposes. Unfortunately, I could not get a clean sample of the sand, as it had been removed, and was mixed with cinders and other extraneous matter.

The railway-well marked "A" on Plate LII., fig. 1, is sunk to a depth of 358 ft. below the surface of the ground. The water rises in a pipe to a height of about 43 ft. above the surface. The pressure was 20 lb. on the square inch, indicated on an ordinary pressure-gauge at the surface of the ground. The discharge at ground-level was 4,300 gallons per hour.

The following is a note of the depth of the various strata passed through in sinking:—

	Depth. Ft.	Total Depth. Ft.
Blue clay	41	41
Shingle	65	106
Blue clay	22	128
Shingle	22	150
Blue sand	27	177
Shingle	13	190
White clay	24	214
Shingle	3	217
Papa	8	225
Light-blue sand	20	245
Clay	2	247
Silty sand	27	274
Cement	5	279
Sand (water-bearing; good flow here)	6	285
Shingle	35	320
Cement	1	321
Sand (timber in this)	4	325
Cement ..	15	340
Papa (water here)	16	356
Sand ..	2	358
Shingle.		

This well was successfully sunk by Mr. E. J. Martin, of Palmerston North.

I give below particulars of two other wells sunk in the vicinity of Longburn. Well marked "B" (Plate LII., fig. 1), 6 in. diameter, is sunk for the Longburn Freezing Company. It is situated about 20 chains south-east of the company's well, and passes through the following strata:—

	Depth. Ft.	in.	Total Depth. Ft.	in.
Clay ..	46	0	46	0
Shingle ..	57	0	103	0
Clay ..	17	6	120	6
Sand ..	44	0	164	6
Clay ..	5	0	169	6
Sand ..	12	6	182	0
Clay ..	11	0	193	0
Sand ..	5	0	198	0
Clay ..	7	0	205	0
Sand ..	65	0	270	0
Shingle ..	6	0	276	0

This well discharges not more than 1,000 gallons per hour.

There is another 6 in. well and a 2 in. well at the freezing-works. The 6 in. goes to the same depth as well marked "B." The 2 in. well goes to a depth of 330 ft. approximate, but I have not yet obtained particulars of it. None of the Freezing Company's wells discharge nearly as much water as the Railway Company's well marked "A."

Well marked "C" (Plate LII., fig. 1) is situated on Mr. Walker's property, about 100 chains south-east of the Rail-

way Company's well near Longburn. It is sunk in a natural depression of about 10 ft. below the general surface of the ground, and passes through the following strata:—

	Depth. Ft.	Total Depth. Ft.
Surface soil	10	10
Sand and timber ..	3	13
Solid timber ..	3	16
Blue sand ..	1	17
Blue shingle ..	48	65
Blue clay ..	35	100
Blue sand ..	32	132
Blue clay ..	40	172
Blue sand ..	44	216
Shingle ..	1	217

The water rises about 16 ft. above ground-level in a pipe, or, say, 6 ft. above the average surface of the ground.

I may state that Mr. Martin is sinking other wells near Longburn, including one for Mr. Riddiford, between Palmerston and Longburn, on the eastern side of the main road, between the road and the line. It passed through—

	Depth. Ft.	Total Depth. Ft.
Blue clay	40	40
Shingle	35	75
Hard blue clay	20	95
Clay and shingle mixed ..	20	115
Blue clay	11	126
Black sand	12	138
Black sand and timber ..	27	165
Black sand	18	183
Hard blue clay	27	210
Blue sand and shingle.. ..	10	220
Light-blue sand	5	245
Blue clay	20	265

Underneath is shingle carrying good soft water rising 32 ft. above the surface of the ground, and running 72 gallons per minute, or 4,320 gallons per hour, to 2 ft. above the surface of the ground.

It is important to ascertain by analysis the degree of suitability of this water for use in locomotive boilers. I use carbonate of soda and caustic soda in small quantities with all our boiler-water, with a view to neutralise any free acid, and to assist in precipitating any carbonate of lime, that may be present.

Mr. Skey submitted samples of this water to analysis, and reports: "This is a clear, colourless, and feebly alkaline water, containing 12·22 gr. of fixed salts per gallon. These salts are principally sodic chloride and carbonate and calcic chloride. The proportion of lime in the water is 4·28 gr., and of silica 3·01 gr., per gallon. Only traces of sulphates and magnesia are present. As lime, magnesia, and silica are not

present in this water in proportions greater than are here stated, I consider this water is well adapted for use in the boilers of engines generally."

Note by Sir J. Hector.

The artesian wells described by the author are certainly the most powerful and copious which have yet been discovered in New Zealand. The examination of the samples of strata passed through and the details of the various borings prove that the formation pierced is the ancient river-bed deposit of the present Manawatu. The old valley of this river system must be very deep, and it has been filled up by successive layers of material carried forward by the river at a time when the land was at a considerably higher level above the sea than at present. These layers of gravel, sand, and clay were deposited at steeper angles than the present slope of the surface. As shown in Section C, Ashurst, at the lower end of the Manawatu Gorge, is eleven miles from Longburn, and is 238 ft. above the sea; Palmerston is 103 ft. and Longburn 62 ft. above the sea. The general slope of the surface is therefore about 16 ft. per mile. The information obtained by the borings that have been made, and from the inspection of sections along the river-terraces, indicates that the layers of river-deposit dip to seaward at 30 ft. to the mile. All the absorbent beds in this ancient river-course must be saturated with soakage water from the higher levels, and when the non-absorbent tough layer that seals down a water-carrying bed is pierced by the pipe the water will rise to a height proportionate to the altitude of the outcrop of that layer further up the river.

At this point water absorbed into the porous strata near the junction of the Porangahau and Manawatu at Ashurst will, according to the foregoing estimates, be reached at a depth of 380 ft. above Longburn, but, as the difference of surface-level between the two places is 176 ft., when the water springs to the surface through the artesian-well pipe it must have a very considerable head of pressure notwithstanding that the percolation is through yielding material.

EXPLANATION OF PLATE LII.

Fig. 1. Sketch-plan: Longburn to Manawatu River.
Fig. 2. Rough section of same.
Fig. 3. Section from Longburn to Ashurst.

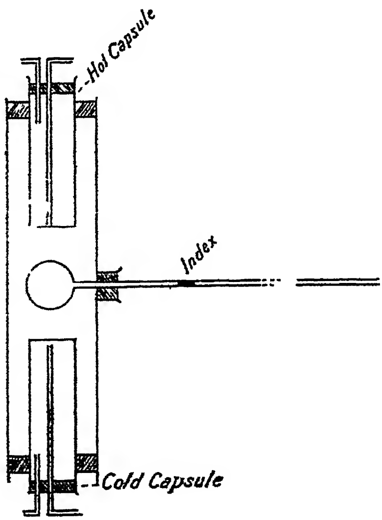
IV.—CHEMISTRY AND PHYSICS.

Art. LI.—*An Instrument for roughly determining the Relative Thermometric Conductivities of Liquids.*

By Dr. W. P. Evans.

[Read before the Philosophical Institute of Canterbury, 4th May, 1898.]

Two similar capsules of thin glass or metal are placed vertically, one over the other, with the bulb of an open-air thermometer between them. The two capsules and the bulb are enclosed in a cylinder of considerably larger diameter, the



capillary stem of the thermometer coming in a horizontal direction through the cylinder wall. Through the upper capsule the vapour of some boiling liquid, or, if more convenient, warm water at constant temperature, is passed;

while cold water circulates through the lower. The liquid to be experimented on fills the cylinder, and finds itself, therefore, between the two capsules. After a time, depending on the thermometric conductivity of the liquid, a state of constant flow is set up. To compare two liquids the time to reach the constant state for each is measured, and the thermometric conductivities are then inversely as the times.

Naturally the apparatus lays no claim to scientific accuracy; it enables one, however, quickly, and with fair success, to demonstrate the relative conductivities of any two liquids. If the stem of the open-air thermometer is of fairly true bore, the relation between the times necessary for any required rise of temperature, or between the times for successive equal increments, also allows of easy demonstration.

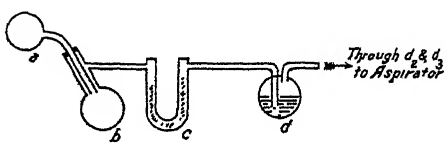
Art. LII.—*On the Distillation Products of the Blackball Coal.*

By Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Part IV.

The following experiment was carried out with the object of testing the results *re* distribution of sulphur arrived at in Part I.* :—



The coal was placed in a bent bulb-tube of hard glass (*a*), connected in series with a Würtz flask (*b*), a U-tube (*c*) filled with dry cotton-wool, three small wash-bottles (d_1, d_2, d_3) containing an ammoniacal silver nitrate solution, and an aspirator. The aspirator was arranged so as to just counterbalance the liquid columns in the wash-bottles. The tube containing the coal was hooded with asbestos millboard, and very gradually brought up to a full red heat. At the end of

* Trans. N.Z. Inst., vol. xxx., p. 489.

the experiment the neck of the tube retort was sprung off above the bulb which contained the coke.

Weighings, in Grammes.

Tube (*a*), empty	...	52·801	∴ Coal ...	10·058
„ + coal	...	62·859		
Flask (*b*), empty	...	43·560	∴ Tar, &c. ...	3·012
„ + tar, &c.	...	46·572		
Tube (*c*), empty	...	27·580	∴ Tar, &c. ...	0·006
„ + tar, &c.	...	27·586		
Neck of tube (*a*) + tar	...	18·604	∴ Tar, &c. ...	0·139
„ cleaned		18·465		
			∴ Total liquid distillate ...	3·157
Bulb of (*a*) + coke	...	39·715	∴ Coke ...	5·379
„ (52·801 − 18·465)	...	34·336		

That is, coal gave 31·38 per cent. of tar and water, 53·48 per cent. of coke, and 15·14 per cent. of gas and loss; as compared with 29·25 per cent. of tar and water, 57·25 per cent. of coke, and 13·50 per cent. of gas and loss of former series.

The silver-sulphide from the three wash-bottles gave 1·347 gr. of metallic silver, equivalent to 0·2126 gr. of sulphuretted hydrogen, or 0·2001 gr. of sulphur.

The coal contained 4·63 per cent. of sulphur, of which (*vide* Part I.) 50·5 per cent., or 0·233 grammes, should have been expelled in the gaseous distillate.

That 83·8 per cent. of this calculated amount was actually accounted for as sulphuretted hydrogen is a further justification of the conclusions arrived at in Part I.

ART. LIII.—*Contact Metamorphism at the New Brockley Coal-mine (Malvern Hills).*

By DR. W. P. EVANS.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

THE local metamorphism of carbonaceous beds, such as coal-seams, is always interesting. The literature of the subject is, however, somewhat scanty, and the conclusions arrived at by different writers, especially as regards the distance through

which igneous action may be traced, very varying. It seemed, therefore, advisable to take the opportunity afforded by the new Brockley tunnel of studying the influence of the dolerite dyke, through which the tunnel cuts, upon the various strata in its immediate neighbourhood.

For position of mine and general geology of district, see "Brockley Coal-mine and Surrounding District," by S. H. Cox, in the "New Zealand Geological Reports," 1882, page 57: "On Mount Somers and Malvern Hills District," by S. H. Cox, in the "New Zealand Geological Reports," 1883–84, page 33: and "Malvern Hills," by Sir James Hector, in the "New Zealand Geological Reports," 1870–71, page, 46; and Sir Julius von Haast, in the "New Zealand Geological Reports," 1870–71, page 135, and 1871–72, page 46.

Conditions at Mine.

Entering the main tunnel, which cuts the dyke nearly at right angles, the following strata are passed in turn, the miners' names being used: (1.) Dolerite, about 300 ft. (2.) Fireclay (so-called), 7 ft. 10 in. (3.) Greystone, 5 ft. 7 in. (4.) Plumbago, 4 ft. 6 in. (5.) Anthracite, 2 ft. 6 in. (6.) Ordinary coal-measures, about 130 ft. (7.) Brown coal, 3 ft. (8.) Measures, 12 ft. (9.) Brown coal, 4 ft.

At the time of my visit, owing to a fall in the tunnel, no specimens could be taken from the inner end. The brown coal spoken of later was taken from the centre of the 3 ft. seam, where it has been cut by an upper drive. For other specimens I take this opportunity of thanking Mr. Henry Lee, the working manager at the mine.

1. *So-called Fireclay and Greystone.*

These are undoubtedly products of contact-action. It is in the case of argillaceous rocks that we find the greatest variety of products resulting from such action. "When fine-grained siliceous clays are exposed to the action of heat by contact with igneous masses they pass into the hard compact materials often called hornstones, porcellanites, &c., and in some of these materials traces of fossils contained in the original rocks may still be detected."*

The whitish outer band of porcellanite and the inner grey, or rather blue-grey, stone will probably prove to be but parts of the same stratum. At some distance from the dyke, fossil remains—charred imprints—of the flattened stems or leaves of old vegetation are often to be found. (It is, however, quite possible that the outer portion of the white-clay rock has been

* Judd's "Lyell" (1896), page 556.

derived from the dyke itself, as many instances are recorded of such "white rocks." Microscopic observation should in that case show traces of the original crystalline structure of the igneous mass, though the component minerals would, of course, be entirely altered. Chemically it is certainly quite within the range of possibility that the reducing action of the carbonaceous materials which must have abounded in the clays near the dyke should be exercised through a distance of several feet.)

This "white rock" should prove of economic value. It could well be used for road-metal, and when ground down (it pulverizes fairly easily), and mixed with some lighter fire-clay, should make excellent firebricks, or a resisting lining for furnaces. Similar material, ground to a fine sand, is much used in England in the casting of brass.

2. *Plumbago (so-called) and Anthracite.*

Both of these seams fall really under the same heading. Anthracite is generally defined as "the densest, hardest, and most lustrous of all varieties of coal." It burns with very little flame, but gives forth great heat—contains very little volatile matter; splinters when heated, and ignites with difficulty. Its colour is generally given as black. Its fracture is lamellar, parallel to the bedding, and conchoidal in other directions. Ure * includes three varieties—viz., anthracite proper (defined much as above); culm, an impure shaly kind; and fossil coke, an American form, more compact than artificial coke, and supposed to be produced by the action of trap rocks on anthracite (*sic*).

The plumbago of the Brockley Mine is such an anthracite shale, and will be reported on in detail (as also the outer white rock) in a subsequent paper.

The anthracite, or, as it might also apparently be named, "fossil coke," is a really useful seam, and should prove of great value as a fuel, either alone or mixed with the hydrous coals of the inner seams. It is rather coky in appearance, is semi-lustrous, does not soil the fingers, is hard to powder in a mortar, but, owing to the marked development of the lamellar structure, and the existence in places of a columnar structure at right-angles to the bedding-planes, easy to break into lumps. It gives very little flame, contains but little over 1 per cent. of sulphur, and, except for the somewhat high percentage of water, has every characteristic of a true "fossil coke," or stone coal.†

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* "Dictionary of Arts, &c.," vol. i., p. 744.

† For analytical details of these coals, see below Art. LIV., "Analyses of New Zealand Coals."

3. *Brown Coal of the 3ft. Seam.*

This is a compact fairly hard coal, which weathers well, and is in every way superior to the average coal of the district. Mr. Page, of the chemical department of Canterbury College, kindly placed at my disposal a sealed specimen of the altered brown coal from the old Brockley working, so that I was enabled to compare it directly with the coal now being got out. The comparison showed that the coal-substances of the two are very much alike. The present coal, being near the surface, contains, however, as would be expected, more ash and more water per cent. than the old. Already, as the drive gets further in, this proportion of ash is lessening. The coal burns well, and is almost entirely free from the fetid odour so noticeable with many of the Malvern "browns."

Origin of the Anthracite.

The anthracites of Europe and America are almost universally held to represent the final stage of that natural process of destructive distillation which has given us the whole range of brown and bituminous coals. The reason for the change is in some instances fairly obvious; in many others, however, still a mystery.

Generally speaking, we may divide the main anthracite beds into three groups—(1) Those apparently due to the direct action of heat; (2) those apparently due to the direct action of pressure (and heat?); and (3) those whose origin is still unaccounted for.

To the first class belong the smaller anthracite seams in the neighbourhood of igneous dykes and floes. That these dykes actually alter ordinary coals in the direction of anthracite is a well-established fact.

Woodward,* in speaking of the various characteristics of the South Staffordshire Coalfield, says, "The Rowley Rag basalt is well known in connection with the district; according to Jukes it forms part of the coal-measure series, having been poured out as a sheet of lava during this period. The coal beneath the basalt has been altered, and has lost its inflammability."

Again, "The Cleveland, Cockfield, and Annathwaite dyke commences six miles south of Whitby, and extends . . . more than ninety miles. . . . It is probably of Tertiary age. In some localities where it does not reach the surface it has been proved in colliery workings; but the coal in proximity to the eruptive rock becomes anthracitic, and ultimately worthless."

Professor Hull mentions that at Whitwick a sheet of

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* "Geology of England and Wales," by H. Woodward, p. 189, &c.

dolerite intervenes between the coal-measures and the new red sandstone. At Whitwick Colliery it is 60 ft. thick, and has turned to cinders a seam of coal with which it comes in contact.

"The Cornbrook Coalfield is to a large extent covered by basalt, from 60 ft. to 150 ft. thick, and in some places the coal is altered and 'sooty.' The known instances of this class are well summed up by Geikie in his 'Outlines of Field Geology.'"* "Sometimes," he says, "the coal has been entirely consumed, and a layer of igneous rock has taken its place. At other times a thin sheet of molten lava has been injected along the top, bottom, or centre of the coal-seam, converting it into a kind of anthracite or into a mere cinder. Examples may be found where the coal has been fused into a cellular mass, and has subsequently had its vesicles filled with infiltrated carbonate of lime. In Ayrshire numerous beautiful sections have been laid bare, when the coal has been rendered prismatic, the hexagonal or polygonal prisms, like so many bundles of pencils, diverging from the surface of the intruded igneous rock."

To the second, or "pressure," class belongs the great anthracite bed of the Appalachian system. "In Pennsylvania the strata of coal are horizontal to the westward of the Appalachian Mountains, where Professor Rogers pointed out that they were most bituminous; but as we travel south-eastward, where they no longer remain level and unbroken, the same seams become progressively debituminized in proportion as the rocks become more bent and distorted. At first on the Ohio River the proportion of hydrogen, oxygen, and other volatile matters ranges from 40 to 50 per cent. Eastward of this line, on the Monongahela, it still approaches 40 per cent., when the strata begin to experience some gentle flexures. On entering the Appalachian Mountains, where the distinct anticlinal axes begin to show themselves, but before the dislocations are considerable, the volatile matter is generally in proportion of 18 or 20 per cent. At length, when we arrive at some isolated coalfields associated with the boldest flexures of the Appalachian chain, where the strata have been actually turned over—as near Pottsville—we find the coal to contain only from 6 per cent. of volatile matter, thus becoming a genuine anthracite."† Portions of the Pembrokeshire anthracite beds of the South Wales Coalfield belong to this class.

To the third class belongs much of the South Wales anthracite. Speaking of the gradual change in character of

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* "Outlines of Field Geology," by Sir A. Geikie, p. 160.

† Judd's "Lyell," page 33.

the coal, Hull* says, "Nor was this alteration . . . accompanied by outburst of igneous rocks, or by violent crumplings and contortions of the beds . . ; on the contrary, the strata are usually but slightly thrown out of the horizontal position. Other causes must therefore be sought for. . . . We may offer conjectural solutions of it, such as the greater increase of temperature over the western or anthracitic region as compared with that over the eastern; or that owing to fissures exceptionally numerous in the western area greater facility was afforded for the escape of the gaseous products. But none of these reasons are quite satisfactory, and this remains one of the problems in physical geology which yet awaits solution."

Both the causes directly mentioned above—rise of temperature and increase of pressure—seem competent to bring about the chemical action necessary for that gradual elimination of oxygen and hydrogen which produces an anthracite from an ordinary hard or even a soft hydrous variety of coal. In the case under consideration—the Brockley—there is abundant evidence also of both. The dyke is large, and, even if, as seems at first sight most probable, it is the result of a single effort of injection,† must have elevated the temperature of the surrounding strata considerably during a long interval of time.

That enormous local pressure must also have been brought into play is evident from the fact that the measures have been thrown into a vertical position by the dyke, and in part actually overturned.

The two causes are also almost inseparably connected. Increase of pressure would certainly result in increase of temperature‡ and chemical action dependent thereon, even if the rise of temperature were not evident, and the increase of temperature due to the injection of the dyke would in many instances be followed by a great increase of pressure as the mineral masses composing it took solid form.§

The Brockley dolerite dyke has certainly come close enough

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* E. Hull, "The Coalfields of Great Britain," 3rd ed., p. 259.

† Such a dyke is usually fairly homogeneous, and therefore probably fills a fissure opened by the pressure accompanying its injection. (See O. Fisher, "Physics of the Earth's Crust," p. 283.)

‡ Mr. Sorby has suggested that under the conditions which exist within the earth's crust there may be even a direct conversion of mechanical into chemical energy, and that many familiar geological phenomena will have to be explained in this way. (Proc. Roy. Soc., 12, p. 538.)

§ The result of recent experiments appears to show that such substances as whinstone and granite are less dense in the solid than in the liquid state at the melting temperature, and must therefore expand on solidifying." (Fisher, *op. cit.*, p. 291.)

to the coal-measures to account for the production of the anthracitic shales and anthracitic seam by rise of temperature only, if such a limitation were necessary. Personally, I do not think there is any necessity to demand a great rise of temperature. A moderate rise of temperature, combined with a considerable increase of pressure, would, I believe, completely determine the required elimination of volatile matter, especially as that elimination would be aided by the fissures sure to be formed by increase of pressure.

ALTERATION OF BROWN COAL AT SOME DISTANCE FROM THE DYKE.

It has at times been urged that the action of the dykes must be limited to a few feet or yards at the most, and that the alteration of brown coals at a distance of some 50 yards cannot therefore be attributed to such action. The researches of Professor Spring,* of Liège, upon the effects of pressure, apart from those of elevation of temperature, seem to answer this objection.

Amongst other interesting conclusions, Spring states that the rubbing or sliding of the particles of solid bodies over one another under intense pressure powerfully promotes chemical action between them; and that *when the particles of solid bodies have been brought into contact by intense pressure, the chemical action between them goes on even when the pressure is removed.*

If, therefore, during the injection of a dyke into or past coal-measures the coal-seams are subjected, as we may surely suppose, to intense pressure, there is reason to believe that the natural processes of oxidation would receive a great acceleration, and that even after the pressure had been equalised again those oxidizing processes would, at any rate for a considerable period, continue at the rate induced by pressure.

It is, I believe, somewhat in this direction that we must look for an explanation of the altered brown coals of the Brockley.

EXPERIMENTAL.

It should—at least, indirectly—prove of value if experiments were carried out with the object of determining the effect of (1) pressure, (2) elevation of temperature, on the ordinary (so-called unaltered) brown coals of the district. The question as to whether the anthracites had ever been

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* Journ. Chem. Soc. (London), 1890, p. 404.

subjected to a high temperature would be rendered easier by a determination of the electric conductivity of various specimens.

Art. LIV.—*Analyses (Technical) of New Zealand Coals.*

By Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 2nd November 1898.*]

Methods used in determining the Given Quantities.

1. *Water.*—Coal (3 gr. to 6 gr. in platinum boat) heated in toluol bath* (107° C.), in current of dry coal-gas, and water given off absorbed in weighed chloride of calcium tube. Time of heating, three hours.

2. *Ash.*—The dry coal, from water-determination, heated in platinum boat over flat Teclu burner till of constant weight.

3. *Sulphur.*—Eschka method, spirit flame only being used; checked where result seemed abnormal by Carius method.

4. *Coke.*—Muck's normal test in closed platinum crucible over free Bunsen flame.† Heating continued for thirty seconds after disappearance of luminous flame.

5. *Heating Effect.*—The values given are calculated according to a formula suggested by the American Coal Analysis Committee in their preliminary report.‡ As the heating values of coals Nos. 1–10 had previously been directly determined by means of a Hempel calorimetric bomb, I was able to compare the values given by the formula with those obtained by absolute combustion. As these values, together with other details regarding coals Nos. 1–10, will shortly be published, I need here only remark that the American formula gives very good results for the hard coals (1–5), but that in the case of the brown coals (6–10) the values, though in the same relative order as those determined by actual combustion, are not so widely differentiated.

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* Trans. N.Z. Inst., vol. xxx., p. 495.
† Muck, "Steinkohlenchemie," p. 8.
‡ Chem. News, 1898, p. 75.

Reference Number.	Name of Coal and Source of Specimen used.	Composition. 100 Parts Raw Coal contain				Coking. 100 Parts Raw Coal give			Coking. 100 Parts Coal Substance give		Heating Effect (calculated).	
		Water.	Ash.	Sulphur.	Coal Substance.	Coke.	Fixed Carbon.	Volatile Matter other than Water.	Fixed Carbon.	Volatile Matter.	Calories per Kilogramme Fuel.	Units-mass Water at Boiling-point per Unit-mass Fuel.
1	Blackball	4·29	1·30	4·74	89·67	45·77	44·47	49·92	49·59	50·41	7427·6	13·85
2	Coalbrookdale	2·75	1·52	2·04	93·69	59·65	58·13	37·60	62·40	37·96	7643·0	14·25
3	Brunner	1·17	7·88	2·35	88·60	58·03	50·15	40·80	56·60	43·40	7245·2	13·51
4	Westport-Cardiff	4·68	0·63	0·87	93·82	57·17	56·54	38·15	60·26	39·74	7606·7	14·18
5	Granity Creek	2·08	0·60	1·51	95·81	57·40	56·80	40·52	59·28	40·72	7793·1	14·53
6	Allandale — From Canterbury College Engineering Department	12·67	6·88	1·77	78·68	49·05	42·17	37·28	53·59	46·41	6412·9	11·96
7	Kaitangata	17·06	5·14	0·28	77·52	45·13	39·99	37·81	51·58	48·42	6267·1	11·69
8	Nightcaps	19·42	3·62	0·23	76·73	43·07	39·45	37·51	51·41	48·59	6201·7	11·57
9	Springfield	20·10	7·81	0·42	71·67	42·18	34·37	37·72	47·95	52·05	5800·7	10·82
10	Shag Point	11·83	7·54	0·62	80·01	50·40	42·86	37·77	53·56	46·44	6481·8	12·09
11	Brockley anthracite: new working (taken at mine—W. P. E.)	9·29	5·38	1·22	84·11	88·65	83·87	2·06	99·71	0·29	6836·9	12·75
12	Brockley altered brown: new working (taken at mine—W. P. E.)	17·42	9·80	0·50	72·28	43·80	34·00	38·78	47·04	52·96	5853·1	10·92
13	Brockley altered brown: old working (from Canterbury College chemical department)	12·22	1·22	0·55	86·01	49·82	48·60	37·96	56·50	43·50	6963·6	12·91
14	Levick's Malvern: trade sample (per J. T. Brown and Co.)	27·95	3·25	0·52	68·28	34·65	31·40	37·40	45·98	54·02	5531·1	10·31
15	Homebush (from trucks at mine—W. P. E.) ..	26·45	2·33	3·59	67·63	34·42	32·09	39·13	47·44	52·56	5603·0	10·45
16	Hikorangi (through R. D. Duxfield, Esq.) ..	5·86	2·92	3·80	87·42	46·35	43·43	47·79	49·67	50·33	7208·1	13·44
17	Kawakawa (through D. J. Kirkpatrick, Esq.) ..	3·09	2·50	4·92	89·49	47·50	45·00	49·41	50·28	39·72	7420·3	13·84
18	Westport-Cardiff: Hannah Hector outcrop (from Christchurch agents)	4·38	0·62	0·54	94·46	57·35	56·73	38·27	60·05	39·95	7644·7	14·26

Art. LV.—*On the Apparent Occlusion of Sulphuretted Hydrogen in a Bituminous Coal.*

By Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

While pulverising a sample of coal from the Westport-Cardiff Company's Hannah Hector outcrop a distinct odour of sulphuretted hydrogen was noticed, and a sensitive lead acetate paper held in the mortar was coloured light-brown. This result was the more remarkable as the Westport-Cardiff coal had been proved by repeated analyses to be freer from sulphur than the average hard coal of the West Coast district.

The finely pulverised coal lost all trace of the sulphuretted-hydrogen smell in a few minutes, and then contained 0·54 per cent. of sulphur. The coal in question is a fairly hard black coal, very lustrous, and often shows a finely developed conchoidal fracture. It does not soil the hands at all, and contains, as is the case with all the Westport-Cardiff coal, only a very small percentage of ash* (0·62 per cent. as average of many determinations). To the naked eye the coal is, except for the fissures parallel to the bedding-planes, as homogeneous as a coal could be expected to be, and quite unlikely to contain any large cavities filled with gaseous matter. When, however, we remember that even the densest of rock-forming minerals often contain cavities filled with compressed or liquefied gases, there seems no *à priori* reason to doubt the possibility of such gas-filled hollows existing in a piece of apparently solid coal.

Sulphuretted hydrogen is certainly formed in large quantities by the reduction of sulphates in the presence of organic matter and subsequent elimination of the sulphur from the resulting sulphides.

That brown coals have the power of absorbing a large quantity of sulphuretted hydrogen is also a well-established fact, and the large percentage of sulphur in many brown coals known to contain but little iron-pyrites has been attributed by Mr. Skey to this absorption of sulphuretted hydrogen.† So far, however, I have not succeeded in finding any recorded

* For other analytical details see above Art. LIV., "Analyses of New Zealand Coals," No. 18.

† Appendix A to Jurors' Reports, New Zealand Exhibition, 1865, p. 369, where several interesting experiments by Mr. Skey are briefly outlined.

instance of a hard bituminous coal giving off sulphuretted hydrogen at the temperature of the air.* One or two European coals, all more or less hydrous, give off small quantities when boiled in water, but it is very difficult to say whether these are parallel instances. Water may have power to decompose many of those complex organic sulphur compounds whose existence in coal is almost certain, but of whose actual properties we are still entirely ignorant.

ART. LVI.—*On the Interaction of Cyclones upon one another.*

By Major-General SCHAW, C.B., R.E.

[*Read before the Wellington Philosophical Society, 20th September, 1898.*]

Plates LIII. and LIV.

LAST year, in a paper read before this Society on the 14th July, I gave the history of two storms—the one antarctic, the other tropical—which met in the region of Cook Strait on the 30th January, 1897, and which seemed to repel one another, the antarctic storm being diverted southwards and the tropical storm northwards. This year—in June last—a somewhat similar meeting between an antarctic and a tropical storm took place; but, instead of repelling one another, the antarctic storm blended with and absorbed the other, in the same way that one antarctic storm often blends with another which has been delayed, and which it overtakes.

The two storms to which I drew attention last year were moving in nearly opposite directions when they met and repelled each other; and I suggested that probably there was a limiting angle between the directions of the tracks of two storms whose paths met inside of which angle they coalesce, and outside of which they are diverted. This supposition appears to be supported by the behaviour of the two storms which coalesced on this occasion, and the limiting angle seems to be about 120°.

The circumstances on this occasion were as follows: On the 23rd June a tropical cyclone of moderate intensity, and moving slowly from north-west to south-east, struck the northern extremity of New Zealand. The force of the wind was sufficient to interrupt telegraphic communication as far

* As the gas was evolved during the act of pulverisation, local increase of temperature due to mechanical action may have to be taken into account.

south as a line joining New Plymouth and Gisborne. The isobar 29·7 was recorded at Patea and Napier and 29·9 at Westport and Castlepoint at 9 a.m. on that day.

On the 24th the storm had progressed so far south that the isobar 29·9 had reached the Bluff with east wind, and the barometric reading was as low as 29·3 on the line from New Plymouth to Russell, with wind from the north and east. The centre of the disturbance was to the immediate west of this line, and was probably about a hundred and fifty miles wide from east to west and four hundred miles long from north to south. The whole area of the storm within the isobar 29·9 extended from New Caledonia, or a little to the west of it, to about the same distance to the west of Chatham Island, or nearly one thousand four hundred miles, and perhaps nine hundred miles across in its widest part.

On the 25th the centre of the storm, included within the isobar 29·3, had reached the line Castle Point to Wanganui with easterly wind, and thence round to Gisborne with westerly wind. The eastern boundary of the central area was probably two hundred miles eastward of Napier. The total diameter of the storm within the isobar 29·9 was about one thousand two hundred miles, and it was approximately circular, the original pear-shape having been modified by the resistance met with in passing over New Zealand.

But now an easterly moving antarctic storm is approaching from the west, its centre being somewhere south-west of Tasmania, and its eastern edge, with north wind, close to the western edge of the tropical cyclone, with its south wind; the divide between the two circulations being about two hundred miles to the west of Milford Sound. (See Plate LIII.)

On the 26th the tropical storm has advanced to the south-east so far that the south-eastern edge of the centre isobar 29·3 has reached Chatham Island with its north-easterly wind. The general shape of the outline of the storm has been changed from the original pear-shape, with its long diameter lying north-west to south-east, into an oval, with its long diameter lying north-east to south-west, and the north-west isobar 29·6 about one to two hundred miles to the east of New Zealand from the East Cape to Dunedin. In the meantime the antarctic storm has advanced eastwards, and has partially blended with the tropical storm, so that the isobars 29·9, 29·8, 29·7 include both storms; but there is a divide between the antarctic isobar 29·6 with north-east wind and the tropical isobar of 29·6 with south-west wind, a little to the east of the east coast of the South Island. The advancing edge of isobar 29·3 of the antarctic storm has just reached Milford Sound. Over the North Island lies a "high," with anticyclonic circulation, included within the isobar 29·7, the

highest pressure recorded being at Rotorua, 30·5; a divide with opposite circulations running round the west, north, and east of the northern part of the North Island.

This small anticyclonic "high" seems to have been formed during the blending of the outer parts of the two storms by the rapid onward movement of the antarctic storm, and probably the peculiar bend in the circulation of the antarctic isobar 29·6 at New Plymouth gives an illustration of the way in which the more rapidly progressing storm blends with the other which is moving more slowly. (See Plate LIV., fig. 1.)

On the 27th June the tropical storm has disappeared entirely; so also has the small anticyclonic "high" which was formed over the North Island. They seem to have neutralised one another, while the antarctic cyclonic circulation has closed in on both sides, and the eastern edge of its valley has advanced eastwards about half-way between Christchurch and Chatham Island, stretching north also into the open sea to the east of Napier. (See Plate LIV., fig. 2.)

The onward rate of progress of the tropical storm moving from north-west to south-east was about two hundred and fifty miles in twenty-four hours, while that of the antarctic storm moving eastward was about five hundred miles in twenty-four hours, both being retarded by the land which their tracks crossed. These tracks crossed each other at an angle of about 45°; both were moving eastwards, but as the tropical storm moved also to the south its eastward velocity was not more than one-fourth of that of the antarctic storm, which therefore overtook it, and blended with it.

In the case last year, when two such storms repelled one another, they were moving, one from the north and the other from the south, without much easterly tendency in either case.

It is abundantly evident from my observations of a balanced wind-vane during the last year that the circulation in cyclones is chiefly upwards in combination with the horizontal circulation, and in anticyclones it is downwards; and the upward motion in the former is more apparent near the earth's surface than the downward motion in anticyclones, which is quite what might be expected. As yet I have been unable to detect any distinct indication of the upward motion being greater or less in the front part or rear part or on either side of a moving cyclonic circulation, and the motion is so complicated that no one has yet been able to follow it accurately. The numerous observations that are now being made in Europe and America with kites and balloons will, I hope, soon throw light on the subject, and may enable us to understand the interaction of cyclones upon one another.

Art. LVII.—*Further Light on the Circulation of the Atmosphere in the Southern Hemisphere.*

By Major-General Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

Plate LV.

Having been favoured by J. L. Barthorp, Esq., an experienced officer of the New Zealand Shipping Company's steamers trading between England and New Zealand, with extracts from the logs of twelve voyages between the Cape of Good Hope and New Zealand, and of eleven voyages between New Zealand and Cape Horn, during the years 1891 to 1898, I have learned so many interesting facts from the ships' logs regarding the circulation of the atmosphere in these southern oceans that they appear to me worthy of record for general information.

These voyages have been made between the south latitudes of 35° and 57°, those to Cape Horn being, of course, more southerly than those from the Cape of Good Hope, though in both a somewhat southerly course has been pursued, both to shorten the distances by great-circle sailing and also to benefit as far as possible by the usual westerly counter-trade winds. It will be seen, however, by the logs that this latter advantage is not always obtained, easterly winds being not infrequently experienced. These easterly winds are sometimes experienced with a high barometer, indicating an anticyclonic circulation very much farther south than has generally been supposed to be the case. Strong indications indeed are given that there is a second belt of anticyclones between the latitudes of 60° and 70° south, in addition to the well-known belt of anticyclones usually lying between the latitudes of 20° and 40° south, and that between these two anticyclonic belts cyclones move eastwards, their northern parts giving the westerly strong winds usually felt; but occasionally, as the ship goes far south and the cyclone travels northwards, the southerly part of the circulation is felt, with low barometer and east winds.

The rate of eastward travel of these cyclones appears to correspond generally with that of the steamers, averaging ten to twelve knots an hour; so that a vessel may voyage eastwards for many days in the comparatively fine weather of the intervals between the following cyclones, or in the stormy weather within one of them; but occasionally the cyclones travel much

faster, as in the voyage of 1897, in which a cyclone and its following anticyclone overtook the ship.

Our Australasian experience has shown us that the neutral line between the anticyclones and the cyclones south of them is variable within wide limits, and that occasionally the centres of southern cyclones reach as far north as 47° or further, and the northern boundaries of anticyclones occasionally are displaced as far south as about 47°; yet an anticyclone lying altogether south of latitude 56° was to me at least a new fact.

It is no doubt possible that such southerly displacements of the regular anticyclone belt normally lying in about latitude 35° may occasionally occur. We notice that in the voyage of the "Aorangi," leaving Wellington on the 22nd December, 1893, an anticyclone extended for about fifteen hundred miles south-eastward from Wellington, the south-east extremity being in latitude 56°; but in the voyage of the 6th July, 1893, we notice the ship passed the northern edge of an anticyclone, in latitude 56¼°, to the west and south of Cape Horn. I feel constrained to regard this very far south anticyclone, and probably many others observed in these voyages in far southern latitudes, as belonging to a different category from those to which we are accustomed in these latitudes, and to indicate, as above mentioned, a second belt of anticyclones lying south of the parallels of 50° to 55° south. The observations of the limited number of explorers in antarctic regions concur in noting very low barometer readings in the summer in latitudes between 65° and 75° south, and hitherto it has been supposed that a mean low barometer was to be found in all the belt between that very far southern belt and the vicinity of the ordinary anticyclone belt between 30° and 40° south. Now it would seem, however, that the atmospheric circulation is sometimes, if not always, more complicated than had been supposed, and that between the "lows" found in about latitude 45° and those found in about latitude 70° there are generally to be found intermediate "highs," in about latitude 60°. If "highs" and "lows" be viewed, as I believe them truly to be, as positions in which there are descending or ascending parts of atmospheric vertical circulations, then it would seem that over these southern oceans there is usually an intermediate vertical circulation between the descending currents, about latitude 35°, and the ascending currents, about latitude 70°, which produces the normally high and low barometric indications in those latitudes respectively, and that this intermediate vertical circulation is indicated by the high barometer with easterly winds frequently noted in latitudes as far south as 56° or 57°.

This seems to be the chief item of instruction to be gained

from a study of these logs of twenty-three voyages in the Southern Ocean during the last eight years. There are, however, other facts which have considerable value, such as the ordinary rate of eastward progress of the cyclonic storms, which, as I before mentioned, is about ten or twelve knots an hour, although it is occasionally accelerated or retarded, and sometimes is deflected northwards or southwards by the influence, I believe, mainly of anticyclones.

On only one occasion (in April, 1892) is the fact mentioned that observations had been made on the temperatures of the air and the sea in the vicinity of icebergs. Mr. Barthorp, however, informs me that such observations have been regularly made, and with the disappointing result that no reliable information evidencing the proximity of an iceberg is to be obtained by thermometrical observations, but that in the dark, and in foggy and thick weather, the only means available to safeguard a ship against dangerous collisions with icebergs is to keep always a most vigilant look-out.

Assuming that the main cause of high and low barometer readings at the level of the sea is, as I have given strong reasons for believing, downward or upward motions of the air in its vertical circulations, the ships' logs under consideration seem to indicate a normal downward motion between latitude 30° and 40° south, upward about 50° south, and again downward about 60° south, and it would appear that westerly counter-trade winds usually felt at about 40° to 50° south are really the northerly parts of a belt of cyclones, and that when a ship pursues a more southerly course than usual, or when the belts of cyclones and anticyclones are in more northerly latitudes than usual, then easterly winds are experienced, either resulting from the circulation of the southern parts of cyclones or the northern parts of far south anticyclones. This very probable interpretation of the facts observed during the numerous voyages under consideration is, of course, more important to sailing-ships than to steamers; but it may be useful to either, and from a scientific point of view it leads us to conclude that the vertical circulation of the atmosphere between the equator and the poles, although in principle that shown in the diagram attached to my paper on the subject which appeared in the Proceedings of the New Zealand Institute for 1889, is probably somewhat more complicated in southern regions, and of the character indicated in the revised diagram hereto annexed (see Plate LV.).

It may be, however, apart from cyclonic circulation, that there are other special causes producing very low pressure in antarctic regions.

Fig. 1 gives a half-section of the Southern Hemisphere, showing on its edge the probable vertical system of circula-

tion of the atmosphere. The arrows show the directions of air-motion in the successive portions of the great circulation between the equator and the south pole, and also the probable meaning of the high and low mean barometric pressures in these various parts of the circulation, the "highs" corresponding with downward indications of the motion, and the "lows" with upward indications.

Fig. 2 shows on a diagram of half the south polar region, extending as far as the 30th parallel of south latitude, the horizontal circulations of the air corresponding with the vertical circulations shown in fig. 1. The circulations are shown as if they were mathematically circular and equidistant; but we know that in reality they are very irregular, in consequence, no doubt, of the interaction upon one another of the various circulations, of changes in temperature, and of other influences. The diagram illustrates what seems to be the general disposition of the circulations which move eastward round the probable polar anticyclone in alternate belts of cyclones and anticyclones. The arrows show the directions of the winds in the various horizontal circulations. The combinations of the vertical and horizontal motions result in spiral motions.

As regards the origin of cyclones, I have found no fresh light in Mr. Barthorp's logs; but the light I have found on the whole subject has proved to be so different from what I had supposed that it gives no support whatever to the hypothesis, which I ventured to put forward in a former paper, that there is some spot in the antarctic regions which is a specially favourable nursery for the birth of antarctic storms, whence they start on a north-easterly course. These cyclonic storms seem to be an integral part of the atmospheric circulation in the Southern Hemisphere, and I see no reason to doubt my former conclusion that the liberation of latent heat by the condensation of water-vapour and the rotation of the earth are the two main sources of their energy and motion.

With my hypothetic antarctic nursery I must also abandon the idea that the counter-trade winds have anything to do with the eastward motion of the storms, because the counter-trade westerly winds now appear to be themselves only the northerly parts of the cyclonic circulations in latitudes from 40° to 50° south.

The northward or southward deflection which we often observe in tracing the eastward motions of antarctic storms appears to be due to the forms of the anticyclones or land masses they encounter in their progress; and to the same causes we must attribute their frequent deformation from their normal circular or elliptic shape, as by the projection of long arms northward, so often observed here.

P.S.—I should have mentioned that the south polar anticyclone inserted in the diagram (Plate LV.) is at present hypothetical. We have no facts here to guide us; only reason and analogy. The cyclones also surrounding it are evidenced only by very low barometric pressure, and winds in varying directions; and on the eastward rate of progress of these cyclones we have no information.

The evidence for the remainder of the scheme of atmospheric circulation is so strong that it seems to have passed out of the realm of hypothesis into that of established fact in its main features. But it must be borne in mind that the positions in latitude of the belts of "highs" and "lows" fluctuate constantly, and that probably the more northern cyclones may sometimes blend with those farther south in the intervals between anticyclones, and that possibly a similar blending of the more northern anticyclones with those far south of them may sometimes temporarily occur.

Notes on the Ship's Logs.

(1.) *Voyages from Cape of Good Hope to New Zealand.*

25th August, 1891.—The voyage commenced in a tropical storm. The ship soon ran into the anticyclone belt, which was rather more southerly than usual, and in which she experienced some gales, probably caused by the tropical storm on its northern side.

29th February, 1892.—During this voyage easterly winds prevailed, and it would seem that the belts of cyclones and anticyclones were displaced northwards.

22nd May, 1893.—The indications in this voyage were very similar to those in the voyage of February and March, 1892, and lead to the same conclusion: that the high and low belts were abnormally displaced northwards.

5th November, 1893.—The high and low belts were in their usual positions.

1st April, 1894.—The ship ran into a tropical storm on the third day after leaving the Cape; then she passed south of the normal anticyclone belt, and experienced the gales of the northern part of a cyclone, in which she voyaged for about a week. The belts of "highs" and "lows" were in their normal latitudes in this voyage.

18th August, 1894.—Westerly winds and gales were experienced during the whole voyage, showing that the high and low belts were in their normal latitudes.

29th January, 1896.—The "highs" and "lows" were in their usual positions, but the ship voyaged in fine weather in the interval between two cyclones, the hindermost of which overtook her on the last day of the voyage.

12th October, 1896.—The "highs" and "lows" were normally placed. The ship experienced the effects of the northerly parts of two cyclones, and passed icebergs in latitude 45°, longitude 51° to 76°.

24th June, 1897.—A normal voyage. High and low belts as usual.

24th December, 1897.—A normal voyage. High and low belts as usual.

20th July, 1898.—In this voyage much easterly wind was experienced, and the high and low belts were evidently much displaced. In the early part of the voyage a tropical cyclone seems to have forced the northern belt of anticyclones very far south, nearly joining the counter-trade cyclones through them. In the latter part of the voyage the easterly anticyclone weather seems probably to have been due to a northerly displacement of the southern anticyclonic belt.

5th January, 1899.—The whole voyage was in the northern part of a cyclone, with westerly winds. The centre of the cyclone was nearly reached in latitude 48°, longitude 108°, with barometer down to 28·97°. The positions of the belts were about normal.

(2.) *Voyages from New Zealand to Cape Horn.*

2nd December, 1891.—The voyage for nearly a thousand miles east of Wellington was in an anticyclone, the southern end of which was in about latitude 50°, rather farther south than the normal. The rest of the voyage was in the northern part of the cyclone belt, which was also a lttle south of the normal.

17th April, 1892.—The whole voyage was in the northern part of a cyclone which travelled at about the same speed as the ship. The centre was very near in latitude 55°, with barometer 28·67°. Icebergs were passed. No thermometrical indications of their vicinity.

6th July, 1893.—After leaving Lyttelton in the easterly winds of an anticyclone displaced southwards in latitude 47° the ship passed in two days, in latitude 50°, into the northern part of a cyclone, in which she travelled for a fortnight, with westerly winds, when, in latitude 52°, she passed into the southerly part of the cyclone, with easterly winds and rising barometer, in latitudes 54° to 56°, showing that the cyclone was moving in a more northerly track than the ship, and that the northern part of the southern anticyclone belt lay in latitude 56°, farther north than usual.

22nd December, 1893.—The early part of the voyage was in the easterly winds and high barometer of a "high" disdisplaced far south; the latter part of the voyage was in the northern part of a cyclone, as usual, but very near its

centre at one time. Many icebergs were passed in latitude 57°, longitude 160°.

18th May, 1894.—Westerly winds nearly all the way. The ship was for a time in the rear part of one cyclone, and was then overtaken by another, the centre of which passed over her with barometer down to 28·64°, in latitude 56°. These cyclones travelled faster than the ship, which was the "Aorangi," doing probably 14 to 15 knots an hour. Icebergs were passed in latitude 55½°, longitude 104½°.

4th October, 1894.—Westerly winds all the way, in the south edge of an anticyclone at first, then in northerly part of a cyclone which travelled rather faster than the ship.

27th March, 1896.—For about seven hundred and fifty miles east of the Bluff the voyage was in the northerly part of an anticyclone, which was much displaced, probably southwards; then the ship overtook a cyclone moving northeasterly slower than the ship, which passed into its southern part, with easterly winds and rising barometer, near the Horn.

6th January, 1897.—The ship, on leaving New Zealand, experienced gales from north-east to north-west and southwest; with high barometer—probably a detached "high," influenced by "lows" north and south of it. Then the ship ran into the northern part of a cyclone, the centre of which, with winds in all directions and barometer down to 28·51°, was felt in latitude 53¾°; but the ship travelled at nearly the same rate as the storm, and in its northern part.

28th August, 1897.—It is difficult to interpret the great fluctuations in the usual positions of the high and low belts observed in this voyage. The anticyclone in the usual cyclone belt noted in the first part of the voyage was a northern "high" forced southwards by a tropical "low," as we learn from the New Zealand records. The second "high" noted, nearer the Horn, was more probably a southern anticyclone displaced somewhat northwards. The cyclones felt moved, apparently, faster than the ship, and in diagonal courses.

25th February, 1898.—The voyage was made in the northern part of a cyclone which travelled at the same rate as the ship. Westerly winds all the way.

14th September, 1898.—The first part of the voyage was in the southern part of a cyclone, the latter part in the northern part of an anticyclone, latitude 55°, and which latter must have belonged to the southern belt of "highs." Both the cyclone and the anticyclone were somewhat displaced northwards.

[EDITOR'S NOTE.—The extracts from the logs were too voluminous for publication in this volume.]

ART. LVIII.—*On Seasonal Time.*

By G. V. HUDSON.

[*Read before the Wellington Philosophical Society, 8th October, 1898.*]

ON the 15th October, 1895, I read a paper on the above subject before this Society, which, however, was not published in the volume of Transactions, and only an extremely brief abstract appeared in the Proceedings (page 734), which I had not the opportunity of correcting. The subject has, however, evoked considerable interest elsewhere, notably in Christchurch, where a thousand copies of my former paper were printed and circulated during 1896, and serious attempts were made by a number of persons to bring about a practical application of the scheme therein suggested. I should state that these steps were taken entirely independently of any action on my part. Under these circumstances, I therefore think I am to some extent justified in again bringing the subject of seasonal time under the notice of the Society, and I venture to hope that the matter may receive a more serious consideration by members than was accorded it on the previous occasion.

As some of those present to-night may not have heard my original paper, it will, perhaps, be desirable first to give an abstract of it; then to explain that the scheme is really only an extension of the principles followed by astronomers in determining the time standards at present in use; and finally to briefly deal with some of the chief objections that have been urged against the proposal since it was first published.

"In order to more fully utilise the long days of summer, it is proposed on the 1st October of each year to put the standard time on two hours by making 12 (midnight) into 2 a.m., whilst on the 1st March the time would be put back two hours by making 2 a.m. into 12 (midnight), thus reverting to the present time arrangements for the winter months. The effect of this alteration would be to advance all the day's operations in summer two hours compared with the present system. In this way the early-morning daylight would be utilised, and a long period of daylight leisure would be made available in the evening for cricket, gardening, cycling, or any other outdoor pursuit desired. It will no doubt be urged that people are at present quite at liberty to make use of the early-morning daylight in summer without any such drastic alteration in the established order of things as is here suggested. To this objection it may be pointed out that, living as we do

in a social community, we are unable to separate ourselves from the habits of those around us. We cannot individually alter our times of going to bed or getting up, but must fall in with the habits of the majority—at all events, to a great extent. Again, under the present arrangement, those who desire to utilise the early-morning daylight are compelled to take some of their recreation before their daily work and some afterwards, which in many cases results in their having to forego pursuits that they would be enabled to follow successfully if their daylight leisure were continuous.

"At present it may be said that people on an average rise at about 7 a.m., and retire to rest at about 11 p.m. Under the new summer *régime* those would become equal to 5 a.m. and 9 p.m. of present time respectively. Breakfast is usually taken at about 8 a.m., which, under the proposed system, would become equal to 6 a.m. Work begins in most cases at 8 or 9 o'clock in the morning, equal to 6 or 7 o'clock respectively. Dinner, again, is taken at 12 or 1, and would become equal to 10 or 11, and while, at present, work is not ended until 5 or 6 p.m., leaving at the most but three hours of daylight, under the proposed system it would cease at a time equal to 3 or 4 p.m., leaving five hours daylight at the end of the day, the average bed-time becoming, as before stated, equal to 9 p.m.

"The system we now employ has probably been adopted as a convenient one in the winter, and carried on during the summer, when it ceases to have application. With regard to the inconvenience of altering the time twice a year, it does not appear that it would bear any proportion to the advantages gained. The community would certainly be deprived of two hours' sleep on the night of the 30th September in each year, and probably a certain amount of inconvenience would be experienced in altering all the clocks for the following day. The same would apply in a lesser degree on the 28th February, when there would be an additional two hours' night, but people would, no doubt, soon become accustomed to the periodical adjustments. On ship-board, when travelling east or west, constant and extensive alterations of time have to be made, and but little inconvenience is experienced by those concerned. The alteration of time in the transmission of telegrams to and from foreign countries may possibly be urged as an objection, but to this it may be answered that equally extensive alterations have to be made already.

"In favour of the scheme, special attention is directed to the saving of expense in the lessened employment of artificial light; the greatly increased health and enjoyment to the numerous classes who are obliged to work indoors all day, and who, under existing arrangements, get a minimum of fresh

air and sunshine; and the probable resultant increase in the health, morality, and happiness of the community generally.

"The foregoing remarks are framed to apply to us in the Southern Hemisphere, but with the seasons reversed they would, of course, apply with equal force to the Northern Hemisphere."

It cannot be too strongly borne in mind that the time standard in ordinary use—*i.e.*, the mean solar day—is merely an abstraction devised for human convenience, and does not represent any actual time interval existing in nature. The shortest actual and unchangeable time-unit is the sidereal day, or the interval of time taken by the earth in performing one complete rotation on its axis, a measurement which is wholly unsuited to human requirements. The length of the sidereal day is 23 hours 56 minutes 4·091 seconds, the sidereal time, as shown by an observatory clock, thus gaining approximately four minutes each day on the ordinary clock keeping mean solar time. As the sun is not a fixed point in the sky, but is apparently continually moving towards the east, owing to the revolution of the earth around the sun, the earth requires to make a little more than one rotation on its axis to bring the sun to the same position each day. This apparent easterly movement of the sun is the cause of the four minutes difference between the sidereal and the solar day.

Owing to the sun's apparent movement in the sky not being absolutely uniform, but being quickest in December, when we are nearest to the sun, and slowest in June, when we are furthest from him, it is necessary to add or subtract a variable amount in order to obtain a uniform average length of twenty-four hours for each day. This amount, which is added to, or subtracted from, the apparent time as given by the sun, is called the "equation of time," and is stated in most almanacs against each day in the year to which it refers. The equation of time is greatest early in November, when the apparent time as shown by the sun is no less than sixteen minutes in advance of mean time. In Wellington there is, in addition, a constant difference of nine minutes between local time and the New Zealand mean time which is employed throughout the colony; so that, in the early part of November, our clocks indicate a time no less than twenty-five minutes behind that shown by the sun—in other words, when the sun is on the meridian on the 3rd November the time according to our clocks is only 11.35 a.m.

I have been careful to specially point out these various adjustments, which are used by astronomers in computing the standard time, in order to show that the time in ordinary use is only an abstraction, so to speak, specially arranged to suit

human requirements, and does not by any means agree with the time as indicated by the sun.

The above facts are no doubt very familiar to many members, but, as most of the objections which have been urged against my system of seasonal time depend on the assumption that the ordinary time we employ is an unchangeable actuality existing in nature with which we must not and cannot in any way interfere, it has been specially necessary to emphasize the fact that our time is merely an artificial standard, which might be further adjusted if by so doing it could be made more subservient to our requirements.

Although, as above stated, during the early part of November our clocks point to 12 when the sun is actually twenty-five minutes past the meridian, few people are even aware of the fact, and certainly no one suffers any inconvenience from it. The direct effect is, however, to make the mornings fifty minutes longer than the afternoons. If the alteration suggested in this paper were given effect to, the clock would point to 2 when the sun was on the meridian; and I do not think it would cause much more inconvenience than the present adjustment of twenty-five minutes.

It will thus be seen that my scheme of "seasonal time" is only equivalent to an "equation of time" of two hours, to be added on to the present standard time on the 1st October, and to be deducted on the 1st March. When it is remembered that, under the system at present in use in New Zealand, adjustments amounting to nearly half an hour are made without the general public being even aware of the fact, I think it will be agreed that my proposed adjustment of two hours is not likely to cause any very great amount of inconvenience.

For the first two or three days after the alteration in spring the mornings would probably seem rather short, although, even then, they would be very little shorter than they are in midwinter under the present system, and, owing to the rapid lengthening of the day, they would very soon substantially increase. Any slight disadvantages felt in the mornings would, however, be more than compensated by the great increase in daylight in the evenings, as, under the new system of counting the hours, the daylight would last until after 8 o'clock p.m. Both mornings and evenings would continue to lengthen out until midsummer, at which time it would be daylight up till 10.30 p.m. As soon as the daylight became too short again in the mornings—which would occur towards the end of February—the clocks would be put back two hours at midnight on the 28th, and for the succeeding seven months the present time system would again be in force.

Amongst the objections which have been urged against the adoption of my scheme, I shall only briefly deal with those of more serious importance. A number of minor objections have been raised, which have simply arisen through the objectors not having taken the trouble to make themselves conversant with the subject. For instance, it has been urged that this scheme, if carried out, would deprive people of their long winter evenings, those raising this objection evidently having overlooked the fact that, during the seven months of the year which include the winter, the time would remain precisely as it is at present.

A more reasonable objection is that regarding the alteration of the clocks, some contending that it would be better for us to alter our habits during the summer, and leave the clocks alone. The reply to this is that such an alteration in habits would be wholly impracticable, as it would involve endless adjustment throughout the whole of society, which could never be carried out in all its detail. Meal times, arrivals and departures of trains, steamers, &c., opening of places of business, theatres, &c., would all have to be simultaneously altered, whereas, by moving the hands of the clock in the middle of the night, all these adjustments could be effected quite automatically, without disturbing in any way the existing state of things.

It has also been urged that by lengthening the hours of daylight at the end of the day shopkeepers and others might be tempted to extend the hours of labour for their employés. This, it may be remarked, is really a side question which has already been specially dealt with by legislation, and although there are at present nearly two hours' daylight after closing-time in summer, I am not aware that any systematic attempt has been made to lengthen the hours of labour in summer on this account. The milkmen, and other persons who have to begin their work very early in the morning, would undoubtedly suffer under my scheme, as they would have to start their duties in the dark of early morning almost the entire year through. As these persons, however, constitute a very small minority in the social community, it is not to be expected that their personal comfort or convenience would be allowed to interfere with the adoption of the scheme if it were found to be beneficial to the large majority.

The kerosene, gas, and electric-light companies would also suffer severely under the proposed system; but, owing to the saving of artificial light, the rest of the community would gain what they would lose; and it is doubtful whether their interests could be fairly considered against the combined interests of all the rest of the community. It is also likely that during the five months the scheme was in operation indoor

amusements and recreations—such as the theatre, concerts, &c.—would suffer to a considerable extent, as outdoor pursuits would be available to all. A reaction in favour of indoor amusements would, however, inevitably take place during the other seven months of the year, which would very possibly make up for the falling-off during the summer.

I am convinced that all those who believe an abundance of outdoor recreation is the most effective means of securing human health and happiness should support this scheme, as by means of it the average worker in summer would enjoy from four to five hours' fresh air and sunshine after his day's work was done. By it all outdoor sports and pastimes would receive a great impetus—the man of business, for instance, who leaves his work at 5 o'clock would in midsummer have five hours of continuous daylight available, during which he would be at liberty to follow any of the numerous outdoor pursuits, which are so essential to the health and happiness of those whose bread-winning occupation obliges them to remain indoors during the major part of the day.

The school-children, again, would benefit in a similar manner; but it would be essential to fix the times for examinations in the winter—that is, of course, assuming that examinations and the accompanying "cram" must always exist in our educational institutions. Indeed, even under the existing time system, it has always appeared incredible to me that the schools should have fixed the time for the examinations in the middle of summer, thus compelling the students to work at high pressure and remain indoors during the very season when the beauties of nature are at their best, and when it would be most conducive to the physical well-being and happiness of the children to be out in the fresh air.

Another alteration, which would be very beneficial to a numerous class, would be to change the balancing time in many financial institutions in the Southern Hemisphere from the 31st December to the 30th June. The clerical labour necessary at the close of the year in these institutions is generally very great, and those employed frequently have to work long hours for a considerable time. This overtime, taking place during the long evenings of summer, is a much greater hardship than it would be in midwinter, and it would appear that the custom of balancing, &c., in December has been brought from the Northern Hemisphere, where it is suitable, into the Southern Hemisphere, where it is unsuitable.

These two latter suggestions might, of course, be carried out quite independently of my system of time-adjustment, but, in the event of the season time ever being adopted, they would probably follow as necessary consequences.

I am quite prepared to hear it urged in many quarters that we must adhere to old customs, and this, no doubt, will be considered by many as an unanswerable argument against the reforms advocated in this paper. The objections to any alteration in existing methods of measuring time has always been very strongly urged amongst a large number, and was well exemplified by the behaviour of an old couple who lived in 1752, when eleven days were deducted from the year in order to bring the calendar into agreement with the seasons. It is stated that the old couple above referred to insisted on observing Good Friday according to the old style of reckoning. "To this end they walked seriously, and in full dress, to the church-door, at which the gentleman rapped with his stick; on finding no admittance they walked as seriously back again, and read the service at home. But, on the new and spurious Good Friday, they took pains to make such a festival at their house as would convince the neighbours that their Lent was either ended or in abeyance." *

ART. LIX.—*The Wanganui Earthquake of the 8th December, 1897.*

By GEORGE HOGBEN, M.A., Secretary of the Seismological Committee of the Australasian Association for the Advancement of Science.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate LVI.

THE earthquake of the 8th December, 1897, was felt generally in the districts around Cook Strait, from Opunake to Nelson, and beyond those districts as far north and east as Auckland, Gisborne, and Napier, and as far south as Timaru. The returns are sufficiently definite to determine the epicentrum and the velocity, and the circumstances afford a good opportunity of reviewing the data of the shocks in recent years that have proceeded from the same origin.

The returns received from the telegraph-offices through the courtesy of the Telegraph Department were as follows:—

* "Chambers's Astronomy," p. 441.

Place.	Time of Beginning of Shock. N.Z. M.T.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale.
A(*a*) Opunake ..	A.M. 2.41*	E. to W. and N. to S.	20 secs.	Everything on the move; violent oscillation; people awakened; feelings of nausea; small ornaments, &c., thrown off shelves. Long and loud rumbling; shock a succession of violent jerks; after shock loud roaring of surf on shore, and heavy gust of wind; peculiar hissing sound at conclusion of main shocks, followed by a slighter shock	vi.–vii.
Wellington ..	2.41*	(?)	some secs.	Several clocks stopped at 2.41 in Wellington Post-office, including the tower-clock. Very unpleasant rumbling noise previous to shock [Prolonged tremor; violent disturbance, then vibrations; doors burst open at General Post Office; bells rung.—*Press Association.*]	vi.–vii.
Napier ..	2.42*	(?)	6–8 secs.	General awakening of sleepers; stopping of clocks. No rumbling during or after shock	vi.
Auckland ..	2.43*	E. to W. (?)	(see next column)	First a slight tremor; then pause from 1 to 2 minutes; then prolonged shock, 20 to 30 seconds. Windows rattled, wooden walls creaked; not felt by everybody; shook beds; awoke some people. No rumbling heard ["Two distinct shocks."—Auckland *Star*.]	v.
Lincoln ..	2.43*	..	..	From Mr. G. Gray and Mr. Coleridge Farr—a good time observation	iv.

Place.	Time of Beginning of Shock. N.Z. M.T.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale.
A(*b*) Gisborne ..	A.M. 2.41½*	S.W. to N.E.	53 secs.	Clock stopped; no alarm. No preceding rumble; at first series of shocks, strong, gradually dying away	iv.–v.
Christchurch ..	2.43	E. to W.*	15–18 secs.	Distinct prolonged shock	iv.
B(*a*) Wakapuaka ..	2.42* (barely)	S. to N.	30 secs.	Loud rumbling, 12 seconds; first shock, 3 seconds; short interval; second shock, 5 seconds; rumble, 8 seconds. General awakening	vi.
Wanganui ..	2.42*	N. to S. and N.W. to S.E.	1 min.	First part very heavy, 15 seconds N. to S.; then sharp upheavals N.W. to S.E., upsetting movable objects and chimneys; tremors gradually subsiding [Sharpest since 1855; 2.40, lasting 3 minutes. Damage in crockery shops; chimneys levelled in all directions; main water-supply stopped; fissures in ground†; subsidence of railway for several chains on reclaimed ground; house burnt down through upsetting of lamp. —*Press Association.*]	viii. +
Picton ..	2 42*	N.W. to S.E.	ab't 1 min.	Two office-clocks stopped. No damage	vi.
Marton ..	2.42*	N.W. to S.E.	20 secs.	Felt by every one. Oscillation of lamps; clocks stopped; some movable objects overthrown; plaster cracked in some buildings; chimneys fell three or four miles off, but none in Marton. One long shock, marked at beginning; gradually increasing, attended by rumbling. Liquids 1½ in. below rim overflowed vessels. Direction, N. of W.	vii. +

* Verified.

† "It has recently been discovered that a piece of ground, 20 acres in extent, near East Tokomaru, twelve miles north of Wanganui, has been torn and rent in all directions by the earthquake which was experienced two months ago. Many of the openings are 10 ft. or 12 ft. across, and strong fumes of sulphur are issuing therefrom."—*Press Association*, 11th February, 1898.

Place.	Time of Beginning of Shock. N.Z. M.T.	Apparent Direction.	Apparent Duration.	Effects. Remarks.	Intensity. Rossi-Forel Scale.
B(*b*) Nelson ..	A.M. 2.43*	N.E. to S.W.	20 secs.	Plaster shaken from ceiling; crockery shaken; sleepers awakened; clocks stopped. Rumble immediately before like approach of very strong gust of wind. Two shocks, 2 seconds between [The first shock for 1 minute, at 2.40. No damage.—*Press Association.*]	vi. +
Blenheim ..	2.42	N.W. to S.E.	nearly 1 min.	Houses creaked; windows shaken; crockery and glasses jingled; sleepers disturbed; town-clock rung. Shock sudden, rocking like jolting in rock; then long tremor and rumbling	vi.
Greymouth ..	2.45	N.E. to S.W.	20 secs.	Doors and windows rattled; sleepers awakened. Some say rumbling before and after—not heard by observer	v.–vi.
Bull's ..	2.42	N.E. to S.W.	50 secs.	One clock stopped; a little crockery broken.	vi.–vii.

* Verified.

Press Association Reports.

Cambridge, 2.43: Woke every one; no damage (vi.). Hamilton, 2.43: Many clocks stopped; no damage (vi.). New Plymouth, 7: Of exceptional duration (v.–vi.). Hawera: Extraordinary severity; no damage (v.–vi.). Masterton: Prolonged and severe; most severe on east coast, where clocks stopped, and people alarmed (vi.). Pahiatua and Carterton, 7: Severe (v.–vi.). Woodville: Lasted 45 seconds; severest for years (vi.). Manaia and Patea: Severe; a few chimneys fell (vi.–vii.). Timaru, iii.–iv.

The earthquake was the severest felt in the colony since the Nelson earthquake of the 12th February, 1893, and the severe effects were more widely felt than in the latter. These two were more severe than any others since the memorable earthquake of the 23rd January, 1855.

Besides the intensity, which was rather over viii. on the Rossi-Forel scale, the prolonged character of the shocks is a noteworthy feature; there were evidently several maxima, and normal and transverse vibrations appear to have been so far distinct in their times of arrival as to give the impression of two different shocks.

A(*a*) and B(*a*) are first-class observations, the times being verified, and other indications of consistency and the known experience of the observers confirming this idea of their value. All the verified times—*i.e.*, A(*a*) and B(*a*)—together with Gisborne and Nelson, were taken at first to form eleven equations of observation. All were counted as of equal weight, for I do not yet see my way to give greater weight to the times from more distant places, as has been suggested. The greater numerical value of the coefficients naturally gives a steadying value, as it should, to the equations based on the data from them.

The normal equations were formed and treated as shown in my previous papers. It hardly seems necessary to give them here.

An examination of the residuals clearly showed the existence of two sets of observations, marked A and B, and led also to the rejection of the returns from Nelson and Gisborne, both of which seemed a little doubtful on other grounds.

The observations in A and B were then examined separately.

Set A.—To find the origin, time at the origin, and velocity of propagation (x, y, z, t, v) there are only five sets of data, and we gain nothing by forming normal equations; indeed, in this case the graphic method of circles is as effective as the method of co-ordinates, and much more manageable. Both were used, in order to have a check on the result. They give the epicentrum R; time at the origin, 2 hours 40 minutes 11 seconds $\pm$ 5 seconds; velocity of propagation, 85–87 miles per minute (7,440 ft.–7,656 ft. per second, or 227,000 cm.–233,500 cm. per second.) The value of z, or depth of origin, is swamped by the high velocity; and we have no means of finding it from the available observations. R is fifty-one miles from Wanganui and seventy miles from Wellington.

Set B.—There being only four places of observation, with the same time at each, the method of straight lines or that of circles can be used. Either gives S for the epicentrum, taking into consideration that the time at Wakapuaka is

given as 2·42 barely, and that the previous rumbling lasted for 12 seconds; so that it was possibly at least 6 seconds earlier. This seems to prevent one being influenced by the times at Nelson and Bull's, which would be satisfied more nearly by an epicentrum nearer R. S is sixty miles from Wanganui and sixty-six miles from Wellington.

The question remaining to be settled is the relation between the results obtained from the sets of observations A and B. They are certainly the observations of two different phases. Are they simply the observations of two different maxima of disturbance, or do those of one set belong to the normal vibrations and those of the other to the transverse vibrations? If the B times give the slower (probably transverse) vibrations, starting from the origin (R or S) at the same time as the quicker (normal) vibrations of A, then their velocity of propagation was thirty to thirty-three miles per minute (2,640 ft.–2,904 ft., or 88,500 cm.–88,600 cm., per second). The difference in the velocities of propagation is very marked; but it must be remembered that the theoretical value of the transit velocity of transverse vibrations at the origin is less than that of the normal vibrations, and that the amount of loss of the former is greatly affected by the question whether the vibrations are along or across the planes of lamination, while the loss of velocity of the normal vibrations is scarcely affected by this at all.

The calculated velocity for normal waves in granite (the elasticity being that determined by Gray and Milne from their experiments on Japanese rocks) is, according to them, 395,000 cm. per second; the velocity of the transverse waves 219,000 cm. per second, or eighty-two miles per minute nearly.* The latter depends on the rigidity modulus and the density only; and Gray and Milne's figure for the former is very low (128×10^6 grammes per square centimetre). Lord Kelvin's figures (157×10^6) gives, I find, about 258,000 cm. per second, or ninety-six miles per minute nearly.

The actual velocity of the waves (B) when observed is about one-third of the theoretical value for transverse waves, and this is not an improbable value; often as much as eleven-twelfths of the theoretical value is lost in the initial stages; after that the velocity remains tolerably uniform. (See Dutton, "Charleston Earthquake"; and Ibbetson, "Elastic Solids").

The explanation, then, that the A observations are those of normal vibrations and B those of transverse vibrations is quite a plausible one, if supported by other considerations. No single velocity that can be assumed will agree with both A

* Quart. Journ. Geol. Soc., vol. 39, p. 139.

and B, even if the times are those of the maxima farthest apart in time, unless we assume a much greater duration of the earthquake than the recorded facts allow us to assume, or unless we suppose the possibility of errors of observation in no way warranted by the character of the returns, which bear internal marks of accuracy, and show in each class a remarkable agreement, Gisborne and Greymouth being the only places where the error amounts to half a minute (and these were not used in the calculation). If the velocities are different the times cannot well be times relating to different maxima of the same series of waves, for the velocity of propagation of the waves of any series will be constant at the origin.* The position of S is not affected by the question just discussed.

The velocity—eighty-five miles per minute, or, say, 7,500 ft. per second (for the A places)—is the highest yet found for any New Zealand earthquake, the velocity in the Nelson, 1893—about fifty miles per minute, or 4,400 ft. per second—being the only one at all near it.

The maximum intensity measured by the acceleration of the earth particle at the surface at Wanganui was about 800 mm. to 900 mm. per second—say, one-twelfth of that due to gravity—according to Holden's mechanical equivalents of the Rossi-Forel scale.†

The amplitude or the period we have no means of measuring, and consequently cannot find the wave-length.

I have drawn the probable isoseismal for the intensity vi. on the Rossi-Forel scale, and partly those for vii. and viii.

On the map I have marked the positions of the epicentra of all the earthquakes of this district for which the data were full and accurate enough for mathematical purposes. They are as follows (approximately):—

F.	Feb. 20, 1890 ...	Trans. A.A.A. S., 1891, "New Zealand Earthquakes."
K.	Dec. 4, 1891 ...	Trans. N.Z. Inst., xxv., p. 362.
A.	July 5, 1891 ...	Trans. N.Z. Inst., xxiv., p. 577.
P.	Aug. 20, 1891 ...	Now first published.
Q.	May 18, 1893 ...	
R. or S.	Dec. 8, 1897 ...	
T.	May 16, 1898 ...	
V.	July 8, 1898 ...	

A large number of other shocks agree generally, as far as

* Ibbetson, "Elasticity Arts," 268 and 276.

† Holden, *American Journal of Science*, June, 1888; Hogben, "Earthquake Intensity in Australasia" (*Trans. A.A.A.S.*, 1893).

the indications given, with the same origin. There is no other shock since the present system of records was begun (*i.e.*, 1890) the data of which are sufficient to determine the epicentrum exactly—in other words, the epicentra given include all those ascertainable at present.

A circle of seven miles radius would include all the points except A, and I think I may justly claim to have found, within the limits of error of our present observations, the region whence the great majority of the Cook Strait earthquakes proceed.

The new instruments about to be set up in the colony will, though not primarily intended for that purpose, no doubt give us information that will help us to determine other elements, especially the period of the vibrations, and, if set up in the proper plane, the amplitude of the vibrations. Hence we can calculate the intensity of shock and the wave-length, and may be led to reasonable speculation on the nature of the underlying rocks between the origin and the place of observation.

Art. LX.—*Notes on the Comparison of some Elements of Earthquake Motion as observed in New Zealand, with their Theoretic Values.*

By George Hogben, M.A., Secretary of the Seismological Committee, Australasian Association for the Advancement of Science.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

The complete mathematical discussion of earthquake movement implies almost the whole range of the theory of elastic solids, and this involves twenty-one constants, with equations connecting them and their functions. A universal solution is impossible, but some very general solutions of particular cases have been obtained, and these can be applied in part to earthquake motion. This is particularly true in regard to moderate earthquakes, or to the motion at some distance from the origin.

One very valuable law, for instance, discovered and proved by Lord Kelvin, is that the most general form of small strain may be resolved into two independent small strains, one of which contributes dilatation and distortion without rotation,

and the other distortion and rotation without dilatation.* That is to say, we may discuss the normal and transverse vibrations separately with some hope of getting an approximation to the actual facts of earthquake motion. If we consider the normal vibrations of an earth-particle at some distance from the origin of disturbance we may take the mode of motion to be wholly irrotational, and it has been shown† that the displacement potential ϕ then satisfies the equation

$$\Omega^2\nabla^2\phi + i^2\phi = o \quad \ldots \quad \ldots \quad \text{(i.)}$$

Ω being independent of i, and, as will appear presently, equal to the velocity of propagation; and i^2 a function of the initial impulse and of the elasticity moduli and the density of the system of particles for the series of vibrations in question.

It is also true that the form of this equation (and hence also the form of its solution) remains unchanged whatever be the value of i for any particular series (provided that the series be homogeneous and isotropic). Now, in the case under consideration we may choose the axis of x in the line joining the origin and the particle considered, and neglect all vibrations except those parallel to the axis of x—in other words, if u, v, w be displacements parallel to the co-ordinate axes, we may put

$$u = \frac{d\phi}{dx},\, v = o,\, w = o.$$

So that ϕ is a function of x only, and equation (i) reduces to

$$\Omega^2\,\frac{d^2\phi}{dx^2} + i^2\phi = o \quad \ldots \quad \ldots \quad \text{(ii.)}$$

every solution of which is of the form

$$\phi_1 = \text{A}\sin.\frac{ix}{\Omega} + \text{B}\cos.\frac{ix}{\Omega}$$

for any particular i series.

The corresponding partial solution for ϕ may be written in the form

$$\text{C}_1\sin.\frac{i}{\Omega}\,(x - \Omega t - \text{S}_1) + \text{D}_1\sin.\frac{i}{\Omega}(x + \Omega t - \text{T}_1)$$

where C_1, D_1, S_1, T_1, i, Ω are unaltered as long as the same series of waves—that is, due to the same impulse at the origin—propagated through the same isotropic solid, are being considered.

The displacement potential has the same value when we put $t = o$, $t = \frac{2\pi}{i}$, $t = \frac{4\pi}{i}$, &c., x being constant—*i.e.*, while we

* Ibbetson, "Elastic Solids," p. 286.
† Ibbetson, *l.c.*, p. 288.

are considering the same particle—that is, the waves have a period $\frac{2\pi}{i}$ seconds.

Again, if t be constant, the potential will have the same value when $x = x_1$, $x = x_1 + 2\pi\Omega/i$, $x_1 + 4\pi\Omega/i$, &c., or the same phase will occur at intervals from the origin of $2\pi\Omega/i$, which is therefore the wave-length.

Hence the velocity of propagation = distance between the equipotential surfaces divided by the period = Ω, which is independent of i, and therefore the same everywhere in an isotropic elastic solid. Ω will be the same for all the waves proceeding from the same origin by the same path, provided they travel through an isotropic solid. Hence there will be no confusion between the different phases of the normal waves of an earthquake, or what in seismology we term the "maxima," as at different places they will succeed one another at equal intervals, unless their paths have been through strata differing greatly from one another in character for some considerable distance: mere differences in surface strata would not appreciably affect the question.

The value of Ω is given by $\Omega^2 = \frac{k + \frac{4}{3}n}{d} g$, where k = elasticity of volume, n = rigidity modulus, in the usual gravitation units; and d = density in units of mass per unit-volume.

Major Dutton has shown that the velocity of propagation is constant within the limits of errors of observation,* and I have always made this assumption in calculating the elements of New Zealand earthquakes. It is here shown theoretically to depend on the hypothesis that the waves have travelled for the greater part of the distance through what may practically be regarded as a homogeneous solid. Hence we may infer that their path has been for the most part through the deeper strata, and that the origins are deep. All these inferences are borne out by the investigations of the best-observed shocks in New Zealand, by their self-consistency, and by the comparatively great depth—often twenty to twenty-five miles —which must be assigned to the origins in the cases where the data have been sufficient to determine them. It seems likely that we may, especially with the new instruments, have the means of determining the period of vibration, and (less truly) the amplitude; these, with the transit velocity, would enable us to draw conclusions as to the structure of the underlying rocks (from the value of Ω), and as to the character or amount of the impulse at the origin of disturbance. I have shown elsewhere that the transit-velocity of the normal waves in the

* "Charleston Earthquake."

Wanganui earthquake of the 8th December, 1897, was about eighty-five miles per minute, or, say, 225,000 cm. per second. The value, according to Gray and Milne (calculated from experiments on Japanese rocks), for normal waves in granite is 395,000 cm. per second.*

Approaching the question of the motion of an earth-particle from another point of view, and regarding it as in most cases approximately simple harmonic vibration, we have $2\pi a = VT$, where a = amplitude, V = maximum velocity of particle, T = period in seconds, and the maximum acceleration = intensity $= \frac{V^2}{a}$.

Now, from cases in which the number of vibrations per second have been noted, I should judge that in the case of the most violent New Zealand earthquakes these have been about three per second. If we take $T = \frac{1}{3}$ in the case of the Wanganui earthquake, and the intensity to be between viii. and ix. on the Rossi-Forel scale, or, say, 900 mm. per second according to Dr. Holden's equivalents, then we have $\frac{V^2}{a} = 900$, and $\frac{1}{3}V = 2\pi a$, $\therefore a = 2{\cdot}5$ mm. nearly, or the displacement of any earth-particle was about $\frac{1}{10}$ in.

This is about one-third of the maximum amount of horizontal displacement in the severe Japanese earthquake of the 15th January, 1887, according to the calculations of Professor Sekiya, based upon seismograph tracings. Our estimate would not, therefore, seem altogether improbable—possibly rather too high.

In the absence of accurate data, further speculation would be unprofitable; but I trust enough has been said to show that future investigation and more accurate observation of earthquakes is likely to lead to interesting results.

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* Quart. Jour. Geol. So., vol. 39, p. 139.

Art. LXI.—*The Tasmanian Earthquake of the 27th January, 1892.**

By George Hogben, M.A., Secretary of the Seismological Committee, Australasian Association for the Advancement of Science.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate LXII.

This earthquake was felt over almost the whole of Tasmania; in Victoria, as far west as Melbourne; and in the south-east part of New South Wales. I am indebted for the data to the late Captain Shortt, R.N., who was kind enough to send me the whole of his official returns; to Mr. A. B. Biggs, of Launceston; to Professor Hutton, F.R.S., of Canterbury College, New Zealand; and to Professor Liversidge, F.R.S., of Sydney, who happened to be at Launceston at the time: to R. J. Ellery, Esq., C.M.G., for Victoria; and to H. C. Russell, Esq., C.M.G., for New South Wales. Further details I owe to the *Launceston Examiner*, *Tasmanian News*, and *Telegraph* of the 28th January, 1892. I have also read Mr. A. B. Biggs's letters in the *Launceston Examiner* of the 23rd February, 1892, and the 5th April, 1892. To these papers I would refer any one who wishes to know the more picturesque details of the earthquake.

The Tasmanian returns give the reported times for the beginning of the earthquake from sixty-one different places; but the majority of them give the time only to the nearest multiple of five minutes—perhaps a natural thing for an inexperienced observer to do, yet a kind of observation which one is inclined to suspect in a calculation which requires for its success observations correct at least to within a half-minute—that is, to the nearest minute. All such times, therefore, must be rejected unless we have evidence to show that they were actually correct to the desired degree of accuracy, and checked by Hobart mean time. The rest, except where obviously at variance with any theory of the origin, were included in the normal equations for finding the origin of the earthquake. As a consequence of that investiga-

* This paper was handed to the Tasmanian Royal Society in January, 1893, but the manuscript was lost, and has only now (1898) been found.

tion, I was led to reject all the times from Tasmania except those of Hobart and Launceston. These I place in the first class, as comparatively good times; one or two others—*e.g.*, St. Mary's, Eagle Hawk Neck, Branxholm, and Campbelltown—are probably within about a minute of the true time, but not exact enough to be relied upon, or to be classed with Hobart and Launceston.

One thing is clear from the reports from the various Tasmanian observers—namely, that the earthquake was a compound one, consisting of four (or perhaps five) shocks, three near together (Captain Shortt gives 2.48, 2.49, and 2.50 at Hobart) and one about seven or eight minutes later. In other respects besides the time—as regards the intensity and direction of the shocks—much valuable information can be gleaned from these reports, and there is a general agreement in the conclusions to which they point.

The Victorian returns are eleven in number. The times are shown by the normal equations to be inferior in value to the times for Hobart and Launceston; I have accordingly not put any of them in the first class. Two of the times, however, may be assigned to the second class—Wilson's Promontory (2.49½) and Sorrento (2.51½). These, with Bairnsdale, are set down in Mr. Ellery's list as the most reliable of the Victorian times. Bairnsdale must be rejected unless it refers to the last of the four shocks; even then it is probably two or three minutes out. It may be remarked that Mr. Ellery expresses a fear that the times from Victoria are not exact enough for use in calculations of the origin. Only four times were received from New South Wales; three of these are fairly good, and must be put in the first class. The other—Green Cape (2.56½)—would probably be correct for the last shock.

The second shock was the chief one, and the one noticed most by ordinary people. At several places where the first three shocks were felt their character was clearly distinguished. I propose briefly to discuss the earthquake under the heads—(I.) Origin of shock; (II.) velocity of propagation; and (III.) intensity of shock.

(I.) For the purpose of finding the epicentrum, or point on the earth's surface immediately above the origin of the disturbance, we may use—(*a*) the directions observed at the various places; (*b*) the times of beginning, or any other marked phase of an earthquake; or (*c*) the degree of the intensity of the shock as felt at different places. Of the various methods, those depending on good times—(*b*)—are by far the best, and the indications given by the impressions or observations of direction are the least reliable. I am, however, very far from holding with Mr. Biggs that they are

quite unreliable. In the great majority of New Zealand earthquakes I find that most of the observations of direction, when properly used, give a very fair rough idea of the position of the origin, especially if that is not too far away. A direction-circle drawn as below, for instance, prevents us from hunting on a false track, and in the present case, after drawing that, I should not expect to find the origin anywhere else but east of Tasmania.

What is observed is, as Mr. Biggs says, undoubtedly the direction of the movement of the earth-particle, or of what depends thereon—the movement of the ground or of objects resting upon it. But this movement is by no means arbitrary, nor can the movement of the earth be compared to the rolling of a ship on the waves. The earth's crust is an exceedingly rigid and highly elastic mass, not homogeneous certainly, but so nearly so in effect that, as Major Dutton has shown in his celebrated memoir upon the Charleston earthquake, we shall not go far wrong if we treat it as homogeneous. Then, the vibrations from a shock at any point within it must obey the ordinary laws of vibrations. The vibrations set up will in general be of two kinds—longitudinal (that is, to and fro along the line of propagation of the wave, like the vibrations of the air in a tube along which a sound-wave is sent) and transverse (that is, at right angles to the line of propagation, like the small vibrations set up in a stretched string by a blow upon it). For instance, if an earthquake were sent from A to B, the longitudinal vibrations would be backwards and forwards in the directions of the arrow-heads, and the transverse vibrations would be to and fro across the line AB, as CO (see Plate LXII.).

At any distance from the origin, considerable compared with the depth of the actual centrum, the longitudinal vibrations will be nearly horizontal; while the transverse vibrations will give rise to up-and-down movements, to horizontal movements at right angles to those of the longitudinal vibrations, and to movements in directions between those of the up-and-down movements and those of the horizontal transverse vibrations, but always at right angles to the longitudinal vibrations, unless there has been reflexion or some other cause of disturbance of the direction of the earthquake-waves. The seismograph record of almost any considerable earthquake will show these several movements more or less distinctly. The disturbing causes are not likely in the majority of cases to make much difference for an earthquake like the present, of intensity vi. or vii., unless the formation of the underlying strata be very peculiar indeed.

Generally speaking, the longitudinal waves seem to reach any given place first; but often only the one kind of vibration

is felt, or only one direction is observed. To use the directions, then, we evidently have the following rule: Draw two lines through each place, one in the direction named in the report, the other at right angles to it; one of these two lines will be very possibly that of the direction of the shock. In the diagram, for instance, the shock felt at O might have come from any of the four directions, AO, BO, CO, DO, but it could not have come from X.

The apparent directions were given for twenty-one places in Tasmania as follows: Launceston, E. to W. (second shock); Scottsdale, N. to S.; St. Mary's, E. to W. (second shock); Swansea, W. to E.; Eagle Hawk Neck, N.E. to S.W. (second shock); Boobyalla, S.E. to N.W.; Cape Portland, S.E. to N.W.; Ormley, W. to E.; Avoca, E. to W. (second or third shock); Franklin, S.W.; Beaconsfield, E. to W.; Sorell, S. to N.; Geeveston, N.W. to S.E.; George's Bay, N.E. by N. to S.W. by S.; Buckland, E. to W.; Oaks, E. and W.; Campbelltown, S.E. to N.W.; Karoola, N.W. to S.E.; East Devonport N.W. to N.E.; Blessington, from N.W.; St. Helen's, E. to W.

The directions for Australia were given as follows: Omeo, S.E. to N.W.; Bairnsdale, W. to E.; Grant, N. to S.; Forster, S.W. to N.E.; Genoa, W. to E.; Cape Everard, S.W. to N.E.; Gabo, E. to W.; Walhalla, N. to S.

Now, drawing lines in the directions indicated, we find we can describe a circle to cut or touch lines through twenty out of the twenty-nine places. The centre of this direction-circle is D. Its radius is large (eighty miles); so that the indication is only rough. The effect of the direction-lines of two or three places of the nine whose lines do not cut the circle O would be to throw the origin somewhat further to the east. We should therefore expect to find the origin either within or somewhat to the east of the circle D.

The indication, if any, given by the directions reported by ordinary observers is only rough, and I should not have dwelt so long upon it but for the circumstance that it is the custom to despise it altogether, a prejudice which experience in the calculation of a very large number of earthquake origins in New Zealand has shown me to be wrong. One cause of error in observing the direction must be noticed: When the method fails the failure generally is not due to eccentricity in the movement of the earth-particle, but to the neglect of the observer to take into account any peculiarity in the method of support of disturbed objects which would tend to make them move, whatever the direction of the disturbing force might be, in certain directions only.

I. (*b*.) The determination of the origin by means of the observed times of the same phase of the earthquake is far

more exact. The time I have taken is that of the beginning of the second shock (or maximum). The times in Class I. are: Launceston, 2.48½ a.m.; Hobart, 2.49 a.m.; Kiama, 2.52½ a.m.; Kiandra, 2.52½ a.m.; Bombala, 2.49½ a.m.: all Hobart mean time.

For Launceston I had three returns: Mr. A. B. Biggs, 2.48½; Captain Shortt, 2.49; Professor Liversidge, 2.48. The time sent to Captain Shortt is noted as probably not quite at the beginning, so it is a little too late; that given by Professor Liversidge is probably too early—there was a little delay in finding the matches, and allowance made for such delay during an earthquake is generally rather too great. Mr. Biggs took the time by a chronometer at once. All the times were verified as soon as possible afterwards by standard time. I think we may say, in taking 2.48½ as the right time, we are correct to the nearest half-minute. At Hobart three shocks were noted—two slight and one sharp. Three were also noted at Carnarvon and other places, and in each case the middle shock—that is, the "second" shock referred to above—was the severe one: Hobart, therefore, 2.49. Great care seems to have been taken in checking the New South Wales times, and they are at least correct to the nearest minute.

The times which at first I placed in Class II. were: Glenora, 2.51; St. Mary's, 2.49½; Eagle Hawk Neck, 2.49; Fingal, 2.50; Branxholm, 2.47; Campbelltown, 2.47½; Sorrento, 2.51½; Wilson's Promontory, 2.49½.

Method of Co-ordinates.—After some preliminary trials by the methods of straight lines* and circles, I formed the equations of observation for all the places in Classes I. and II. as in Milne's "Earthquakes," p. 206, and then the normal equations from them (see "Merriman's Method of Least Squares," chap. iii.). No good result was obtained, however; but the conclusion could plainly be drawn that the times in Class II., being more or less inconsistent with one another, were less reliable than those of Class I.

The weights assigned for the several observations were: For Hobart, 25; for Launceston, 16; Kiama, 9; and for the rest, 4, 2, or 1.

I then returned to the method of circles, which, with data of the kind we have, and for an earthquake whose origin is not near any of the places of observation, is as good as the method of co-ordinates. C_{20} is the epicentrum obtained by

* S was obtained by the method of straight lines from the two pairs, Kiama-Kiandra (2.52½), Hobart-Launceston (2.48½). It corresponds to a surface-velocity of about twenty-six miles per minute. Subsequent comparison of the records, however, for reasons already given, led me to believe that 2.49 was the true time for Hobart, or as near as we could get to it. S remained as a rough first approximation.

taking the times for Kiama, Kiandra, Launceston, Hobart, with a velocity of twenty miles per minute. Bombala, Launceston, Hobart give C_{35}, with a velocity of thirty-five miles per minute. This also agrees to about a minute with Campbelltown, Wilson's Promontory, Kiama, and Kiandra. Still more nearly do C_{30} and C_{25} agree with the times in Class I., though still not exactly. I then, with varying velocities from twenty miles to thirty-five miles per minute, attempted to find some small area (or comparatively small area) a simultaneous shock from which would reach the five places in Class I. at the several times observed. With a velocity of about twenty-six miles per minute we can get such an area, marked EE′ on the map. The degree of agreement with the data may be tested by the time at the origin, as calculated from the different places. This time should, of course, be the same from whatever place we calculate it. We get the same time—2 hours 35 minutes a.m.—from each of the five places in Class I.

The places in Class II. give this time as follows: St. Mary's, 2.38; Glenora, 2.36·4; Eagle Hawk Neck, 2.35·8; Fingal, 2.37·9; Branxholm, 2.34·7; Campbelltown, 2.34·5; Sorrento, 2.32·3; Wilson's Promontory, 2.33·8. The average or arithmetical mean of these is 2 hours 35.4 minutes a.m., which certainly does not contradict the evidence of the best times.

The epicentrum I therefore take to have included the whole or part of the shaded strip EE′, and not to have extended nearer to any of the places of observation than EE′. How far it may have extended to the south-east it is, of course, impossible to say, as no observations were made on that side—probably not very far. EE′ is about forty-eight miles long and four miles wide in the widest part. It lies between 153° 56′ and 154° 36′ east longitude, and between 41° 13′ and 40° 46′ south latitude. E is 353 miles from Launceston and 365 from Hobart.

V_{35} is the position I have found for the epicentrum of a previous well-marked earthquake—that of the 13th May, 1885. V_{35} is only seven miles from the boundary of EE′, and the two results seem thus to confirm one another in a remarkable manner. The confirmation is all the greater as the area over which the two earthquakes were felt was practically the same.

S, T is the position assigned for the same earthquake (13th May, 1885) in the late Captain Shortt's map (as corrected by himself), of which he kindly allowed me to take a tracing. He seems afterwards, in a paper read before the Royal Society of Tasmania, on the 16th November, 1885, to have expressed an opinion that the origin lay rather further to the north, and thus, I presume, not very far from V_{35}, my own result.

I have also examined the data for two of the other well-known earthquakes—the 13th July, 1884, and 19th September, 1884; they are scarcely exact enough for a good determination of the epicentrum, but in both cases point to an origin about fifty miles north-north-west of V_{85}. These estimates, again, rough though they may be, are not widely at variance with the more exact results of the present investigation. Mr. A. B. Biggs, of Launceston, has assigned a different position altogether for the epicentrum of the earthquake of the 27th January, 1892—namely, a point 730 miles due east of Hobart. (See *Launceston Examiner*, 23rd February, 1892.)

This is totally inconsistent with the data, even as given by Mr. Biggs himself. It is always assumed that an earthquake-wave travels with nearly the same velocity throughout; indeed, since Major Dutton's report on the Charleston earthquake, already alluded to, this is taken to be practically settled.

If, then, d_1, d_2 be the distances of two places from the supposed origin, t_1, t_2 the time of the same phase at those places, v the velocity of propogation, evidently we have

$$\frac{d_2 - d_1}{t_2 - t_1} = v.$$

Applying this formula to different pairs of places with Mr. Biggs's origin we get the following values for v: Hobart and Kiama give $v = 11{\cdot}4$ miles per minute; Hobart and Kiandra $= 24{\cdot}3$ miles per minute; Hobart and Bombala $= 30$ miles per minute; Launceston and Kiama $= 8{\cdot}3$ miles per minute; Launceston and Kiandra $= 23{\cdot}3$ miles per minute; while Launceston and Bombala would agree with any velocity whatever.

When we remember, as just stated, that all these values of v should be the same, or very nearly the same, we shall see, I think, that it is impossible to accept Mr. Biggs's theory of the origin.

N.B.—I have used Mr. Biggs's version of the data, though they differ slightly from mine. As a matter of fact, the data he has used give an epicentrum within twenty miles of mine — not one where he has placed it. Moreover, Mr. Biggs puts the origin much nearer to New Zealand—where the earthquake was not felt at all—than to Tasmania or Australia.

The maximum intensity of the earthquake of the 27th January, 1892, was vii. or viii. on the Rossi-Forel scale, as appears from the following summary of the observed effects, which I put here for future reference, though they do not seem to call for any special remarks:—

Place.	Effects.	Intensity Degree on Rossi-Forel Scale.
Hobart	Stopped clocks; overturned flowers; threw down fowls; rang bells; rocked beds; windows rattled; dislodged rocks	vii.
Launceston ..	House shaken considerably; two or three chimneys shaken down or shifted; bells rung violently; furniture shifted; ornaments dislodged; clocks stopped; inhabitants rushed out of houses. (Professor Hutton says bells rung on hill, not on flat)	vii. or viii.
Scottsdale ..	Strongest ever felt; clocks stopped	vi.+
St. Mary's ..	Houses rocked; window-frames and slight articles violently shaken	v.+
Carnarvon ..	Three shocks at 2.50. Pillars of church thrown out of perpendicular	vii.+
Avoca	Loose bricks knocked off chimney (by second and slighter shock at 3)	vii.
George's Bay ..	People frightened	vi.
Buckland	Windows violently shaken ..	vi.
Moorima	Cattle and people alarmed, some rushing out of doors	vi.
Coppington ..	Furniture moved out of its place ..	v.
Ouse	Furniture and curtains shaken. Most severe for thirty-five years	v.
Evandale	Furniture rocked	v.
Longford	Clocks stopped and bell set ringing	vi.
Devonport ..	People complained of nausea; many awakened	vi. (v.)
Blessington ..	Houses shaken	iv. (v.)
Boobyalla ..	Heavy surf broke on bar	vi.
Fingal	Clocks stopped; clocks started; bells rung; plaster fell from walls. Greater than the 13th July, 1884	vii.+
Carrick	Doors and windows rattled ..	iv.
Tartleton	All sleepers awakened	vi.
Ulverstone ..	Windows rattled; persons awakened	..
Penguin	Nearly every one awakened ..	vi.
Stanley	A regular panic occurred ..	vii. (vi.)
Beaconsfield ..	Houses shaken; doors banged; furniture rattled; in mine (Tasmania), 486 ft. from surface, water agitated; pumping-engine rattled violently; post-office clocks stopped; swallows alarmed, and left nests	vii.-vi.
Wilson's Promontory	Light-tower vibrated violently ..	vii.-vi.
Foster	Chimney fell	vii. (viii.)

Art. LXII.—*A Graphic Method of Calculating Cubic Content of Excavation, as for Water-races on Uneven Ground.*

By George Hogben, M.A.

[*Read before the Philosophical Institute of Canterbury, 2nd November, 1898.*]

Plate LVII.

An engineering friend lately asked me if I could find some easy way of calculating the cubic content of excavation of water-races on uneven ground, so as to avoid the heavy arithmetical work involved in the use of the usual formulæ.

The problem set was as follows: Given the areas of two cross-sections (a^2 and b^2), and the perpendicular distance (x) between them, to find the amount of excavation.

The following is a graphic method of arriving at the result. The solution seems rather obvious; but it is new to me, and engineers to whom I have shown it do not seem to know it; so, as it would evidently save a large amount of labour, it appears to be worth while to publish it. a^2, b^2, and x are found by the usual methods employed in surveying (a and b not being found).

The mass to be excavated can be treated as a frustum of a pyramid, and can be calculated from the formula

$$\frac{x}{3}(a^2 + ab + b^2).$$

This involves multiplying a^2 by b^2, finding the square root of the product, and then adding a^2, ab, and b^2 in order to find $a^2 + ab + b^2$, the area of the base of the equivalent pyramid. Logarithms being out of the question, the process is a tedious one.

But $a^2 + ab + b^2$ may be easily found as follows (see Plate LVII.).

Draw two lines at right angles, AOB and OH. Along OA mark off a distance OC on any convenient scale—say, 20 square feet to 1 in.—to represent a^2; and along OB mark off OD, to represent b^2.

Place a set square so that the right angle may be on OH, and the sides containing the right angle may pass through C and D; let the right angle be at E. [If a pencil-point be held at A, it is easy to slide one edge of the set square past A until the other edge is at B and the right angle on OH. Or we can, of course, describe a semicircle on CD instead; it will cut OH at E; then, without altering the compasses, we mark off the radius twice, giving EF = CD.]

OE represents the product ab in the formula (Euclid, vi., 8).

Mark off EF = CD.

Then OF represents $a^2 + ab + b^2$.

(1.) We can read this off and multiply by $\frac{x}{3}$; or

(2.) Use tables giving the content of pyramid with base $a^2 + ab + b^2$ and height x; or

(3.) If the distance between our sections is always the same—say, 162 ft.—we can graduate OH to represent cubic yards—1 in. = 40 cubic yards—and read off the cubic content at once without calculation.

If the distance between the faces is not always the same, we may place the scale at the right-hand side, and have a straight edge or rigid steel wire radius movable about a pivot at S. Move this edge or radius about S until its edge is over F. Run the eye along the edge or radius until you reach, say at F, the vertical line corresponding to the perpendicular distance between the faces, given at the top MHN. The reading on the same horizontal line as this gives the cubic content. (This is easily seen to follow by similar triangles.)

No calculation whatever is needed, and the whole operation may be as readily performed as any ordinary consultation of tables for rectangular areas and volumes.

To avoid the use of a rigid wire or edge for radius—(*a*) A silk thread may be attached at S, and stretched so as to pass over F, and the reading taken as before; or (*b*), if only one or two distances between the faces are commonly used, scales of cubic yards may be constructed to correspond, and the proper scale may be placed along OH, and the cubic content read off thereon.

The scales I have chosen are rather large for practical needs; but it would be easy to put various scales along AOB, MHN, and at the line of volumes at the right, to suit different kinds of work.

Example.—The figure shows the method of calculation for faces of 50 square feet and 70 square feet. With horizontal distance 162 ft. the content is 358 cubic yards; 216 ft., 478 cubic yards, &c.

The method, it will be noted, is an exact one, not a mere approximation; the accuracy depends chiefly on the accuracy of the original measurements, and on the accuracy with which the scale can be read.*

* The scale referred to above can be read much more nearly than probably the areas of the faces can be estimated, for an error of $\frac{1}{4}$ a square foot in each face would give an error of about 3 cubic yards in the result.

V.—MISCELLANEOUS.

Art. LXIII.—*Inaugural Address.*

By Edward Tregear.

[*Read before the Wellington Philosophical Society, 29th June, 1898.*]

The vast range of subjects to be considered if we attempt to view the whole field of science makes it impossible in a single short address to present a picture of the whole. If one evening could be devoted to each branch of science it would perhaps be possible to convey some idea of the present position of knowledge, but even then there would be great difficulty in steering between the Scylla of technical terms that appear pedantic and the Charybdis of loose popular expression. I can only hope to call your attention this evening to a few facts which I consider interesting, and which may have escaped your notice, and I can only do this in a few branches of science by reviewing late additions to our acquaintance with the universe.

First we will take the most ancient and in many ways the grandest department of science—viz., that of astronomy. The great advances that have taken place of late years in exact astronomical knowledge have been achieved not only by the exertions of trained and acute observers, and by the use of more powerful telescopes, but by the aid of photography, spectrum analysis, and other methods of investigation and check. To many of us the interest we take in the solar system is contained in the idea that the other planets may be worlds like our own, that they may be inhabited by people like ourselves, or perchance be our own homes in some future state of existence. Even the hope of being able to communicate with their inhabitants in this life is not considered too wild and visionary a speculation for many people to entertain. Little hope, however, can be obtained in this direction from astronomy at its present stage of development. Some new and surprising discovery, some process as startling to us as the revelations of the spectrum analysis would have been considered fifty years ago, will have to be evolved from the human brain before man is able to set up communication with other planets, and even before he can

be certain that the planets are inhabited. We know little more than this: Mars, the planet best situated for observation, has little or no atmosphere, and therefore, if inhabited, must be so by creatures not formed like human beings. There may, however, be some slight or thin atmosphere, as sometimes light shadows that appear like vapours have been seen on the planetary surface; but even on this point the best observers are doubtful. The polar ice-caps, known since the days of Herschel, do undoubtedly diminish during the Martian summer. Mr. Douglas, of Lowell Observatory, has remarked a dark edge to the melting ice, probably the water into which the ice is converted. This is not certain, because the polar caps may not be of ice at all; they may be of solid carbonic acid. The most eminent physicists doubt whether the sun's rays would have power to melt more than a few inches of snow or ice at the Martian poles. The greatly disputed canals of Schiaparelli are still considered unproven. The word "canal" is a mistranslation of Schiaparelli's word "*canale*"; this, in Italian, does not mean "canal," but "channel," or watercourse. Some astronomers show these channels on their maps of Mars as sharp dark lines passing from point to point on the planet's surface; but Barnard, of the Lick Observatory (one of the most reliable observers, and aided by one of the largest telescopes in existence), says that the so-called channels are indistinct markings too hazy and undefined to be reproduced; this, too, when he is able to give other details not mentioned by Schiaparelli. A curious thing concerning the controversy is that some of the observers of the so-called canals in Mars are able to distinguish similar lines not only on Mercury and Venus, but even on the satellites of Jupiter. The more cautious and conservative astronomers hesitate even yet to accept the Martian canal system, and one of them has caustically remarked that if you wish to see the canals well at night you must fix your eyes all the preceding day on Schiaparelli's map.

The spectroscope in the hands of Keeler has made us acquainted with the fact that the outer portion of the rings of Saturn revolve more slowly than the inner. This implies that the rings are not composed of coherent matter, either solid or liquid, but of a cloud of minute particles, perhaps of a vaporous character, each moving in its own orbit.

It is, however, in the domain of the fixed stars that the most interesting facts have been brought to light, and as spectrum analysis aids the telescope it is to be hoped that even greater wonders will be presented to our grasp. The most marvellous lesson revealed yet is as to the presence of dark, and therefore invisible, bodies in the stellar spaces, and

it is thought certain that many of the fixed stars have dark planets revolving round them. This fact has been affirmed by observations on a class of stars known as Algol-variables, and they are so named after the star Algol, in the constellation Perseus. This star is ordinarily of the second magnitude, but at regular intervals of time, in a little less than three days, it sinks for an hour or two to the fourth magnitude, then resumes its former brightness, the whole change occupying about five or six hours. The fact that there are numerous stars of this character is now fully established; their brightness remains constant for a time, then suffers partial eclipse for a few hours, and always at regular intervals. It was long ago suspected in the case of Algol that this eclipse was caused by the revolution of a dark body round the star, and was fairly well proved by Vogel's measurement of the motion of that star in the line of sight; it is a natural conclusion that the similar and regular eclipse of other stars is due to a like cause. A planet could not be seen to eclipse a star unless our system lies near the plane of its orbit, therefore it is only reasonable to conclude that there are many other planets not moving in such a plane. The eclipses of these planets would not be visible to us, as in such case they would pass either above or below the star. To give some idea of the care and incessant watchfulness necessary for astronomical record it should be pointed out that observations on these Algol-variables have to be made during the time of partial eclipse, and compared with observations at other times. An observer might record the magnitude of such a star on a dozen occasions, and yet never happen to strike the period of obscuration. This new addition to our knowledge proves that there can be no limit to what we yet may learn concerning the suns and worlds in space. Thirty years ago no project seemed more hopeless than that of detecting an invisible planet revolving round some immensely distant sun, but now it is a well-cultivated branch of astronomy.

Another late discovery is that of the companion of the brilliant star Procyon. This star, like Sirius, was thought to have a companion, because by very refined observations of position the visible star was found to revolve round a fixed centre. The companion of Sirius was discovered by Alvan Clark, the companion of Procyon by Schaeberle. Procyon's satellite is found to have a mass of about one-half of its bright star, and the revolution takes about forty years. The companion of Sirius has a mass of about one-third of its brilliant ally, and its revolution is in fifty years. The systems of planets moving about such stars seem to have more eccentric orbits than the planets of our own solar system.

It is one of the triumphs of spectrum analysis to have dis-

covered that some sixty of the fixed stars appear not to be solid bodies, but composed of transparent gas, like a nebula, they showing spectra of bright lines. Most of these gaseous stars are situated in the Milky Way; but observations made at Arequipa, in Peru, on a part of the sky only visible in the Southern Hemisphere, show that some others are visible in the Magellanic Clouds, thirty degrees distant from the Milky Way.

If we turn from the domain of astronomy to that of natural history we may find several new items worthy of note. A very curious variety of ant has been discovered in Northern Australia, near Port Darwin. It is called the magnetic or meridian ant. It is only a variety of the ordinary white ant, but the singularity consists in the arrangement of its nest. This looks like a slab of sandstone put on edge, so that, viewed end on, it resembles a pillar; but the long axis of the nest is always placed due north and south, so that the builders are properly more meridian ants than magnetic ants. A traveller finding one of these ant's nests needs no other compass. The reason of this orientation of the short axis is not yet fully investigated, but it is believed to arise from an effort or instinct in the ant to expose as little as possible of its dwelling to the direct rays of the sun.

Attention has been lately drawn to the curious habit of the Australian "frilled lizard"—namely, that when alarmed on open ground, or at a distance from tree-trunks, it rises on its hind legs and runs like a biped for perhaps thirty or forty yards. It appears strange that in Australia quadrupeds should contract this habit of forsaking the all-fours attitude, and running in an upright position, as the kangaroos and some other marsupials do. It is believed, however, by naturalists that the Dinosaurs, that long-extinct order of reptiles, also moved in a similar way, on the hinder limbs only. While on the subject of reptiles I may mention that it has been adduced as a proof of over-evolution and its drawbacks that the head of the cobra and other hooded snakes often leads to their destruction. These hoods are supposed to be an endowment of the snake for the purpose of terrifying its foes, the sudden and great enlargement of the hood when the creature is about to strike or in times of excitement adding to its formidable appearance. It is now found that the hooded snake, when striking at its foe, often overbalances itself, through the weight of the heavy outstretched hood, and topples forward. Some birds that are snake-killers, and the snake's deadly enemy the mongoose, take instant advantage, and, having tempted the snake to strike and miss, seize it before it can recover, and ripping up the back of the neck kill it at once.

Dr. Arthur Willey has been for some years trying to obtain the eggs of the pearly nautilus. These eggs have been for a long time desiderata of naturalists because the structure of the nautilus is remarkable, and, although that animal is allied to the cuttle-fish, it has many and wonderful points of difference. To fully understand the arrangement of the structure and the building of the chambered cell it is necessary to know more of its younger stages while it is growing and developing within the egg. Dr. Willey spent a year in New Britain, where the nautilus is taken in baskets like lobster-traps at a depth of 70 fathoms of water, but was unsuccessful in the attempt to obtain the eggs. He then tried New Guinea, but nearly lost his life through the upsetting of his vessel. He passed through New Caledonia, which he found unsuitable for his purpose; but, on arriving at Lifu, in the Loyalty Islands, found to his delight that the nautili can there be captured in 3 fathoms of water. He constructed a large submarine cage in which he kept specimens of the nautili, and at last his patient endeavours have been rewarded. Some of the creatures spawned in the cage, and the doctor has been able to collect abundant samples of the egg. Each egg is as large as a grape, and is deposited separately by the mother.

The pearl-shell fisheries, in the lagoons and waters of the islands of the Pacific, have been so ruthlessly exploited that the trade is now being carried on under extreme difficulties. Formerly the pearl-oysters were abundant on the surface of the coral reefs exposed at low tide or in the shallow waters near the shores. These supplies are exhausted, and it has become necessary to employ diving apparatus, which in some cases has to be used at a depth of 80 ft. Something may perhaps be done by perfecting the methods and apparatus used in diving, but far more success will probably attend the new idea of restocking the old beds. Experiments are being carried on both on the Western Australian and Queensland coasts to ascertain if the oyster will grow and propagate with artificial aid. A preliminary experiment made at Roebuck Bay, on the Western Australian coast, in a mangrove swamp covered by several fathoms of water at high tide, has proved that the oysters (placed for safety in wire-covered cages) commenced to propagate within the first year, and young shells were found attached to the parent shells. Succeeding experiments are showing very favourable conditions, and it is probable that, if attention is given to the restocking of the lagoons and shallow reef-areas of the Pacific, investments could be made that would realise immense fortunes for the promoters. Hundreds of thousands of pounds' worth of shell have been taken in a short time from the Paumotu and other island groups now barren of such articles of export. Could the still waters within

the atolls be regularly attended and watched as culture-fields of the pearl-oyster, there is a great commercial future before the pioneer settlers of the South Sea Islands.

In the same part of the world there is sad waste of opportunity in not cultivating the turtle industry. The animals are carefully watched on landing by the keen eyes of natives, and the "nests" of eggs are devoured. If the small turtles, hatched by the sun, could be reared in salt-water ponds—as we rear trout in the fresh waters of this colony—they would escape not only their human foes till they arrived at maturity, but in their babyhood they would be able to be preserved from the crowds of sharks and other fish that await the tiny turtles as they enter the sea in a defenceless condition. This applies both to the edible and the tortoise-shell varieties of turtle; they could be bred for commercial purposes with a minimum of trouble and outlay and a maximum of profit.

The Royal Society's expedition to Central Africa has recorded a remarkable observation in regard to the great Lake Tanganyika. The fauna of the lake is quite unique, and as limited as peculiar. The jelly-fish and shrimps are of marine type, and the water, which Livingstone stated was brackish in his time, is now quite fresh. Lake Nyassa, some 246 miles to the south-east, never apparently had any connection with the ocean, but it seems probable that Lake Tanganyika, a part of the great Rift Valley running through that part of Africa, once had such connection.

Turning from the lower grades of creation to the world of men and women, there is much to interest us in modern geographical and anthropological work. A journey needing great daring and entailing severe exposure was made by Mr. Harry de Windt among the Tchuktchi of Arctic Alaska. He gives us in his account a wonderful picture of the intensity of the struggle for life among the Esquimaux of the far north. They make a habit of infanticide, but even under the extreme pressure of hunger do not carry the practice so far as to indulge in cannibalism of the kind related of an Australian mother who was found in tears, not because of her baby having had to be killed, but because her parents had eaten the titbits. We doubt, however, if any Australians could surpass in dirtiness these Indians of the land of ice. Some of their habits are perfectly indescribable. The Tchuktchi is not prone to suicide, but when a man has reached the point at which he is decidedly not worth his food a family conclave is held, and the whole village assembles around the home of the victim to celebrate his funeral feast. The person in whom all are interested is himself full of lively interest in the proceedings, and, in the midst of a circle of relations, submits himself

to the parting ceremonies. One of his nearest connections places his foot against the old man's back and strangles him with a thong. This seems to be a dreadful custom, but as death from starvation is everywhere around it is more excusable than in a community where food is plentiful. The height of these Indians is greater than that of the ordinary Esquimaux, some of them reaching 6 ft. in stature; they are slim, wiry, and strong. They are good shots with the rifle, expert sailors, and clever hunters, and, like most primitive peoples that lead a hardy life, they have a horror of dying in bed, believing, like the old Norsemen, that a death by violence insures eternal happiness.

The mention of cannibalism suggests that few people are aware that in parts of China cannibalism is sometimes practised. In Dr. Sven Hedin's paper on "Four Years' Travel in Central Asia," read last November before the Royal Geographical Society, he speaks as follows: "When the Dungan village To-ba, which has a strongly fortified position between Ten-kar and Si-ning, had held out for several months it was obliged to surrender, but it did so on the condition that its inhabitants should be allowed to leave the town unmolested. The Chinese accepted the proposal, but required the inhabitants of the town to stack their weapons. This was hardly done before the Dungans were attacked and killed to the last man. The populace howled like wild animals when General Ho's soldiers came back from their campaign with Mahommedan prisoners, who were triumphantly led in chains through the streets of Si-ning to Djen-tai-jamen to receive judgment, which was soon forthcoming. They were led out again, and outside the gate their throats were cut with dull knives. Then the chest of each was opened and the heart and liver stuck on spear-points, and thus carrying these trophies to the nearest eating-house the soldiers had them fried and then ate them up. The Chinese believe that if they eat the hearts and livers of their enemies their courage will be transferred to themselves.

A very curious little race of people has been discovered by Messrs. Olifsen and Filipsen, Danish officers, who have made an expedition to the Pamirs. The race in question is of exceedingly small stature, and their dwarfish habit extends to the lower animals in their possession. The oxen are about the size of donkeys, the donkeys no bigger than dogs, the goats and sheep of the most diminutive description. This peculiarity probably arises from the absence of nutriment on those high and barren lands. This people is badly armed; they are mere savages, and their religion is a species of fire worship.

Colonel Feilden has made an interesting exploring voyage to the little-known Island of Novaya Zemlya. There is little.

of geographical import in the report of the voyage, but the observations on the fauna and flora are worth notice. The colonel remarks watching the king eiders among the other swarming sea-birds, and says that these handsome ducks were such splendid divers that they were bringing up shellfish from the sea-bottom where the water was 60 ft. in depth. Of the abundance of bird life he says, "Dotterels, little stints, purple sandpipers with their freshly-hatched-out broods ran around us; reeves were fewer in number; snow-buntings, shore-larks, and Lapland buntings hopped around; snowy owls sat on the peaty knobs and watched our proceedings with serious interest. The tarns were alive with red-necked phalaropes chasing one another. It was indeed a very delightful experience." We should not expect many flowers in the arctic regions, but the Colonel says, "One may wade through acres of blossoming plants a foot high, veritable arctic flower-gardens. In the end of June and beginning of July *Matthiola nudicaulis*, a delicate pink-blossomed cruciferous plant, with the arctic yellow poppy and louseworts of many colours, from glorious yellows to rich pinks, are spread broadcast. *Polemonium cæruleum*, with its grand blue blossoms, coloured acres. *Saxifraga hirculus*, with its yellow flowers, is perhaps the most abundant and widespread of the plants. *Silene acaulis* is likewise most abundant, growing in clumps and bosses on dry spots and the sides of the ridges among the disintegrated rocks in such dense masses as to give colour to the cliffs. Then comes the alpine forget-me-not, with its lovely colouring, varying from white to the purest cerulean blue. My words fail, I know, to give adequate description of the immense charm attaching to this arctic flora."

Those interested in the branch of anthropology that relates to the weapons used by wild races may care to learn that a near relative of the boomerang has been discovered in use among the Kolis of Northern Gujerat, India. It is not curved as the boomerang is, but rather presents a kind of "elbow" or "knee" in shape; it is very effective when properly thrown at ground-game, but is not cast so as to return to the thrower. In one case lately tried in Court in that locality it was found that an old and feeble man, being threatened by a robber swordsman, cut the assailant's shins across at ten paces distance, and brought him down; then, before the astonished thief could rise, the now unarmed old man had him disarmed and a captive. Mr. H. S. H. Cavendish, who has lately journeyed and explored in Somaliland, also mentions a new and curious weapon. Speaking of the Murle people, on the River Omo, he says, "Their most singular weapon is the circular knife which they wear round their wrist, similar to that described as in use among the

Darsonich. When they are not fighting this knife is covered with hide, so that they may not hurt themselves with it. This weapon they use not only for fighting, but also to cut up their meat when they are eating. It may be described as an iron bracelet with a sharp cutting-edge outside, the blade being about 2 in. to 4 in. wide." I have particularly noticed this weapon, because the thought has struck me that this bracelet-knife may be the progenitor or relative of the quoit-like Asiatic weapon ascribed in the Bhagavat Gita to the ancient Aryans. It is possible that the bracelet-knife of the Murle people might be removed from the wrist and hurled as a quoit-missile against an enemy.

The excavations carried on by the American Expedition in Southern Babylonia bear out the statements previously made as to the extreme antiquity to which we must refer the builders of the old cities. At the mounds of Niffer search was commenced among ruins on a platform that was built by a king named Ur-gur about two thousand six hundred years before Christ. Below this was another platform which Sargon I. built some twelve hundred years earlier, all the bricks bearing the names of Sargon and his son Naram-Sin. Below this were found ruins of temples erected about two thousand years earlier than Sargon's platform; so that we are presented with evidence as to the advanced stage of civilisation that the builders had reached about seven thousand six hundred years ago. Two interesting discoveries have also been made in Egypt—one that of a city of which the name is unknown, and that was once inhabited by some race that was neither Egyptian nor that of the people whose chipped-flint tools were found two or three years ago. In the newly discovered city there was a cemetery containing two thousand graves, and the bodies were not mummified nor embalmed, but were found sitting with the knees bent up to the chin, in that peculiar position which is common to ancient sepulture among primitive people all round the world, in Great Britain as in Polynesia. In some of the graves the skulls were placed in the centre, and lines of bones were set out from these like the spokes of a wheel; but the ends of the bones had been removed for the purpose of extracting the marrow—a fact that points to ceremonial cannibalism at the funeral rites. The other interesting Egyptian discovery was made at the Island of Philæ, on the Nile, an island whose beautiful temples were threatened with destruction by the projected building of a huge dam for irrigation purposes. An alteration of level for the purpose of trying to save the ruin, and only submerging the foundations, caused the institution of an exhaustive survey of the island; and it has been found that the temple on Philæ has (unlike many Egyptian temples)

very solid foundations—so solid, indeed, that there is exactly as much stone-work below the surface of the ground as there is above.

Reluctantly leaving the many items of interest that time will not allow me to bring under your notice, I may call attention to the loss sustained by anthropology generally and by the Polynesian Society in particular by the death of Mr. S. E. Peal, of Assam. He for years with untiring energy devoted himself to studies in ethnology as well as to researches in botany. He tried to direct the attention of scholars to the many points of similarity in customs, costume, &c., between the Nogas and other tribes of Assam and the Dayaks of Borneo and other eastern islanders, urging the necessity of a central society being formed to act as a medium between the *savants* of India and those of Oceania.

The mention of Mr. Peal's death brings me to the sad duty of chronicling the deaths of other well-known and regretted scientific men lately in our midst. The names of Professor Parker, of Dunedin; of Mr. Maskell, Registrar of the New Zealand University; and of Mr. T. Kirk—all distinguished men, regretted by the whole world of intellect—will be trebly mourned by us among whom they lived and worked, and to whom they are endeared by a thousand kindly personal recollections.

The thought of those who have passed away brings one to the consideration of beliefs as to the soul of man, and especially to the different aspects under which the subject is considered by primitive peoples. I had intended to present to you a synopsis of the remarkable inquiries made by M. Zaborowski into the belief held in the double and triple soul by the natives of Madagascar. He compares it with a similar belief among the Nias of the Malay Archipelago, and it appears very wonderful to us, who are in the habit of considering primitive people as simple-minded, to notice the clearness with which so-called savages pursue their inquiries into mental conditions which even to cultured men, with ages of philosophy behind them, appear cloudy and difficult to investigate. But M. Zaborowski's discoveries would need a whole evening in themselves, and I must defer them to another occasion, wishing now to turn to one or two subjects practical to ourselves and to our interests as members of a civilised society.

Perhaps one of the most interesting subjects of study, when comparing savage and civilised men, is as to the amount of moral and social responsibility that should be allotted to each individual. It seems fairly easy to note the degree in which the members of a savage tribe stands to its other members. Well-understood customs and usages, intricate to outsiders but simple to those "to the manner born," regulate every action

of life, and almost even the thoughts of the actors. To civilised men, on the other hand, the law of custom has become confused; religion, morals, legislation, evolution of ideas, exigencies of occupation throw a web of lines and a dazzle of cross-lights over the question of individual responsibility. It would be idle to attempt to consider such a question as regards those of us who are (more or less) sane, because the infinite number of differing cases baffles inquiry, but it is at least open to us to consider somewhat as to the responsibility, or the absence of responsibility, that we impute to the insane. It is one of the saddest of subjects, but with the continual increase of insanity it demands attention. The tendency of education and culture is to empty our gaols and fill our lunatic asylums. It is hardly compatible with such modern culture to hold that an insane person is one "possessed of a devil," and that from such a one the evil spirit can be cast out by any priestly or religious conjuring. But, while we are ready to punish the criminal, and thus declare that we hold him directly responsible for his actions, it may be as well to endeavour to find out how much healthy action may be found as a survival in a diseased mind. The born criminal is now, in prison, ranked with the man who has but once, perhaps, broken the long record of a useful and laborious life by yielding to temptation, and there is no difference made in the law between the man who is criminal because his brain is diseased and the man who, though physically sound, is morally weak. It is an enormous mistake to treat mental deficiency and mental disease as if they were one and the same thing. Mental deficiency indicates insufficient brain development, and may show every variety of moral and intellectual weakness. Idiots and other persons so afflicted may have marked ability in some special directions, such as music; but they are certainly not responsible beings, and can no more be expected to obey the moral laws that govern sane persons than a watch can be expected to keep time if some of its works are removed. On the other hand, and in regard to those suffering from brain-disease, the line between sanity and insanity could not be drawn if the behaviour or conversation of such persons were considered the only criteria of their knowledge of right and wrong. For those who are not conversant with the subject, I will quote as example the report of an interview with a lunatic person—a fair example enough:—

A.B., male; age, 38.

Who are you?—I am a crowned king.

Where were you crowned?—At Corbett and Sullivan's championship prize-fight.

What are you king of?—Emperor of Germany. The Emperor of Germany crowned me, and the arbitrators sanctioned it.

Are your powers mortal or divine?—Divine as far as the truth is concerned.

Are your physical powers great?—Just middling.

Did you ever hold the sun in your hands?—I did.

Did you ever hold the moon in your hands?—I remember the sun, but am not so certain about the moon. The sun was very hot.

How hot was it?—It hurt the leather mits I had on. I think other powers were used on it.

What kept it hot?—It was hot weather.

What caused the trouble you went through?—The Proclamation issued by all Exchequers of all nations and empires.

How did you suffer?—Abuse of all kinds. My body is marked up. I have the leopard's body right through, and my body is spotted like a dog's.

What other abuse have you suffered?—My body has been torn by bears. There were four, brownish-black in colour, two old ones and two young ones.

What is the difference between right and wrong?—It is right to love the Almighty, and to serve him with faith, hope, and charity.

What is wrong?—To commit anything that the law of God forbids.

What is conscience?—The dictates of a man's own mind to tell him if he is doing wrong.

Is it wrong to kill?—Yes.

Is there any justification for murder?—No.

If an insane man committed murder, what punishment would you inflict, if any?—I would not hang him, but put him in safe-keeping, that his neighbours might be safe.

Is any insane man responsible?—Never; neither God nor man can make him responsible. Our Heavenly Father forgiveth, so should we.

Now, no one can believe from the report of the foregoing interview that the patient was sane; yet, although an uneducated man, he had clear notions of right and wrong, at least equal to and as satisfactory as those that guide the bulk of our citizens. We are surrounded in this century with problems and enigmas, but little is done, I fear, to turn public attention to the necessity of procuring the thoughts of the very best trained and alert experts in order to guide us on this subject. We see people set free from asylums as cured, and allowed to return to their families, or to marry and propagate children of infected and tainted blood. Men commit murders, and the plea of insanity is allowed to protect them from punishment when the question of how far they are responsible even if insane on some point is not inquired into. Men and women who are not in asylums, but who are in reality far less morally responsible for their conduct than many who are in those refuges, are allowed by the present constitution of society to hold positions of honour. Surely it behoves us all to take more notice of this spreading and growing weakness of the human race under civilised conditions, and ask ourselves whether we are taking sufficient precautions to prevent the ruin of mankind in the future by our worship of the liberty of the individual—whether that

liberty takes the form of filling the asylums with lunatics or the hospitals with patients.

The correlation of action of mind and body brings to us the consideration of the position held by will and temperament on the conditions of civilised life. If the study of history has its most practical application in teaching us how to avoid the pitfalls into which have fallen the men and women who preceded us upon the world's stage, surely also the most practical lesson to be inculcated by the study of anthropology is the avoidance of evils that in the customs of savages stare at us open-eyed. Are these same evils rampant among us under other names, and disguised under thin veneers of civilisation and culture? In many cases they undoubtedly are, and, although it would take far too long even to attempt to show the hundredth part of the misery that arises from the ages-old mistakes that we hug to our bosoms under new names, there is one at least to which I may call your attention, and that is to the little heed that is given to the training of the will in benign directions, and to the higher discipline of the feelings. It is the tendency of modern life, with its intense efforts of struggle and competition, to exalt in the educated man of the nineteenth century those qualities which in savage life brings the individual to the front, and converts the energetic and resourceful member of a barbarous tribe into the successful war-chief. Nay, more, it exalts those base qualities in man which in the lower stages of his evolution as an animal were his graceful and noble attributes, but which should be left behind him on his ascent from among the lower creatures, for the exertion of such faculties may cause him to become the enemy of his kind and the foe of all that bear the impress of the higher nature.

Unflinching courage, restless energy, unsparing disregard for others that cannot serve his turn, acquisitiveness, lust of power: these are the qualities that in the modern industrial world, as in the realm of savage club-law, command not only the world's rewards but the world's admiration. Some of these qualities, such as courage and energy, are always worthy of respect, worthy now as they were in the old forest days when man shared them with the ape and tiger; but if with these are held up other less worthy qualities—base ambitions, lust of gold, greed of power, &c.—it becomes a matter of doubt whether such mental possessions may not be found to be false lights, leading to ultimate disaster. Let us put aside the social question that presses upon us at every turning of the path, and let us consider only the physical effect upon the millions who must form the crowd from which successful individuals detach themselves. If we think what it must be to live in a continual high strain, we must acknow-

ledge that with the cultivation of the nerve forces too great preponderance must be given to their exercise, and this at the expense of other parts of the human constitution.

Is it possible to so govern the mind and will that they may have a good effect upon the body instead of ill, and may recuperate instead of wasting the physical powers? I believe that it is so possible, and will proceed to lay before you my reasons for considering that in many cases our maladies and weaknesses are the effects of causes within our own control. We are startled year by year with the increasing lists of victims of certain diseases to which the human frame is liable. It is true that skilful surgery has advanced to such perfection that operations once deemed almost certainly fatal are now not only performed daily, but are executed with the very slightest risk to life. On the other hand, diseases such as cancer, tuberculosis, Bright's disease, and other scourges of modern life, appear to be continually widening their fields of advance. My impression is that, although deadly maladies cannot be cured by any action of the mind if they have once obtained firm foothold, even as it would be impossible for the mind to perform a difficult surgical operation, still the preparatory processes, the seed-time if not the harvest of death, can be beneficially neutralised to a degree at present hardly understood.

Here we must plainly distinguish at once between direct thought and the general habit of thinking — *i.e.*, feeling. Of course, we know that our thoughts are sometimes conditioned by the state of the bodily health. For instance, the man whose liver is out of order will see things in a jaundiced manner; he will almost certainly be a pessimist; while the sanguine man—the man who never knew he had a liver, whose blood gushes healthily through his veins—will think cheerfully of life and its surroundings. What we do not recognise so clearly is that by thinking directly, by effort of the will, by concentration of the desire in a certain direction, we may influence our general state of feeling, and so produce a reflex action on the bodily functions. If we allow our thoughts to dwell upon gloomy subjects — some twopenny loss, some fancied slight, some possible calamity that may never arrive—are we not inducing a habit of feeling that may more or less prepare our bodies to act as seed-beds of disease? On the other hand, is it not possible, by concentrating our force of will into meditation on brighter subjects, by leaving the contemplation of evil—especially other people's evil, and the sinfulness of our neighbours—we may make the blood flow more healthily and banish the black humours for which we have blamed our innocent livers, and, indeed, from which the poor liver itself may be suffering?

If we visit a lunatic asylum, and find there the victim of erotic mania, shall we not, if we inquire far enough, find in that victim one who has given his thoughts too full and continual play on forbidden subjects? If we find, too, in that asylum the wrecked slave of alcoholism, is not in many instances the history of such a case the history of one who, little by little, allowed his thoughts to wander away into love of the brain-excitement caused by daily-increasing draughts of a stimulant? If we could look inside the brain of such a man during his early stages of mental disease we should find him occupied with vivid flitting pictures which alcoholism in its early beginnings induces; and a similar position is held by every one of us who allows his thoughts to run wild instead of keeping them under control.

Those of us who have suffered from insomnia know that the effect of that malady is to present continuous pictures to the mind—the mind that turns restless from subject to subject without rein or guidance—till sleep appears impossible, and if too long continued "that way madness lies." But this torture is only an exaggeration of what is passing in the mind of every one in lesser degree who does not keep conscious control over the centres of thought. This waste of the intellectual forces weakens and wears the body, fatigues it to no purpose; it is itself the outer gate of insanity, however disinclined we may be to acknowledge it to ourselves. It is a morbid state, and under it one part of the body at least suffers perceptible decay—that is, the brain—even if no other part of the body is apparently affected. How many old people, or people hardly past middle age, we see whose doddering minds have sunk into senility long before the general organs of the body yield themselves to dissolution.

There is scarcely, perhaps, a dominant state of feeling that, if persisted in, does not bring about a functional disturbance. It is stated that one of the early symptoms of general paralysis is the morbid vanity and boundless self-esteem exhibited by the patient. Is the converse of the proposition not a probable truth—viz., that years of intense self-esteem and colossal egotism—even if concealed—may engender the condition that results in paralysis? Nay, may we not, by indulging in such diseased imaginings, be preparing maladies that, if not evident in our own short lives, may accumulate and be handed on to appear as curses in the lives of our children's children?

It may be affirmed that although the effect of sickness in producing mental depression is common enough, yet that the reverse action has not been noted. If this is so, it is surely only from want of observation and inquiry. We hear of people dying of a "broken heart"; many such cases are

within the experience of most of us. There are few instances, perhaps, where the valves of the heart have been actually ruptured by intense emotion, but numberless instances might be adduced where, within a short time after some great sorrow or disgrace, the body has yielded to the effect of the wounded feelings, and death has resulted. People, too, die from home-sickness—that intense desire and longing for their native country and friends that the Swiss call the "*mal-du-pays*," and in this the mental illness soon reacts fatally on the physical forces.

"We know also that gloom or despair may induce jaundice; that good news will make the heart beat vigorously, that cheerfulness will calm and regulate its beat; that fear and anxiety may paralyse digestion. Some cases of exophthalmic goitre present a curiously symptomatic analogy to the phenomena of fear. There is intestinal laxity, sense of abdominal chill and emptiness, palpitation of the heart and about the abdominal aorta, carotid throbbing and tension about the throat, with protrusion of the eyeballs. A case is cited by Guislain, from Ridard, of a woman who, after seeing her daughter violently beaten, was seized with great terror, and suddenly became affected with gangrenous erysipelas of the breast. Mr. Carter narrates that a lady who was watching her little child at play saw a heavy window-sash fall upon its hand, cutting off three of its fingers, and she was so much overcome by fright and distress as to be unable to help. After dressing the wounds the surgeon turned to the mother, whom he found seated moaning and complaining of pain in the hand. Three fingers corresponding to those injured in the child were discovered to be swollen and inflamed. Purulent sloughing set in. Fothergill says that the most pronounced case of anæmia he ever met with was in a girl of splendid physique and magnificent family history. She was the type of health when her father fell down by her side at market and died there and then. She then became incurably anæmic. Emotion had ruined her blood. Both acute and chronic diabetes frequently own shock or prolonged anxiety as their cause. The same is true of chronic kidney disease, and the same causes form part of the factors concerned in cancer and epilepsy. The hair may turn grey in the course of a night of grief. The milk of a mother in animals and man may be instantly suspended by emotion. Dr. Carpenter records cases in which the milk of nursing mothers, though not suspended, became instantly fatal to their offspring. In the hypnotic state the influence of mind on body is perhaps still more striking. Bivet and Féré record cases of much interest. Postage-stamps were applied to the shoulder of a hypnotized subject, and the suggestion was made that a

blister would appear. In twenty-four hours, when the dressing was removed, the skin was thick, dead and white, puffy, and surrounded by an intensely red zone. The whole was photographed. The temperature of small parts of the body can be raised several degrees by suggestion. Nose-bleeding and blood-sweat have been produced; and in one case the subject's name, traced gently on his arm with a blunt probe, stood out, long after, in times of intense congestion, accompanied by a little bleeding. It is needless further to multiply instances. The point is that, if intense feeling or slighter degrees of feeling, morbid, long-sustained, can intimately affect every bodily process in a marked and vivid manner, producing great alterations of structure or function and chemico-physiological actions, or acute and chronic disease, then those slighter but much more prolonged errors and morbidities of thought and feeling of which we are all guilty from moment to moment and from day to day, those improper and unguarded states of consciousness which we all permit, not even recognising them as improper, must be answerable, as causes, for a large part of the diseases of humanity. And answerable, too, not only for disease, but for the unhealthiness of what we count as health, for the undergrown, short-lived bodies in which we have to dwell so carefully even when we do not have what alone we call obvious disease."*

It may be urged that one must let the mind have play in some direction. That is true, but might it not be in some advantageous direction—in the direction of cheerfulness, hopefulness, thoughts of noble deeds, kind actions, generous impulses; not towards hate, rage, sullen broodings, lust, revenge, jealousy, mean longings, balked ambitions. These latter low planes of thought are the disease-producers; these plough the body as well as the soul, and fit the soil for the germs of fatal maladies. They involve a waste of vitality, and in that waste they beckon to the evil forces that lie in wait for man if the "sound mind in the sound body" is not ready to combat them as the leucocytes in the blood attack the microbe.

An authority—Herbert Coryn—says, "I once saw a case of minor epilepsy gradually improve almost to cure by a prolonged attempt on the part of the patient to cure the irritability of temper to which he was a victim, and to cure the discontinuity of thought and lapses of attention which he had for years permitted to increase. It was an aggravated case of the ordinary mind-wandering, in which we all habitually indulge, and the small fits occurred during the intervals of the lapsing of his attention from, and the return of his attention

* H. Coryn, "Mind as Disease-producer."

to, the subject of which he was speaking. And epilepsy of the greater kind, when the fits are periodic, frequently presents the phenomenon that some one fit may not occur, its place being taken by an attack of ungovernable rage. Taking this fact with my own cited case—the general connection of epilepsy with uncontrolled temper, and the sometimes striking effect of hypnotism in the reduction of the number of fits—I am strongly inclined to regard it as often an heirloom of long periods of time, extending over many generations, during which no control was gained of the moods, and in which every fit of irritability was allowed the utmost scope—was allowed its fling. The connection of epilepsy and of general irritability of temper with the presence of uric acid in the blood—the gouty temper—admits of similar explanation. If rage, sullen moods, fear, anxiety, and some other emotions and colours of feeling can, as we know, upset the liver, and cause the development of uric acid and urates, sometimes along with jaundice, then it would seem probable that, short of these violent outbreaks, a general state of irritability, proneness to acrid criticisms, readiness to quarrel for one's slightest 'right,' to resent trifles, to see intentional offence in innocent acts, may maintain a slight and continued uric-acid condition of blood, and, maintaining the mental state to which it is due, eventuate in a vicious circle. In a phrase, bad temper may be not only one *effect* but also one cause of gout and epilepsy, and of all other maladies due to chemical *auto-toxæmia*. Haig has done much to enlighten us upon the connection of this crystalline poison, uric acid, with a large number of diseases, acute and chronic, functional and organic. It is normally formed in the body at the rate of about 13 gr. per day. Its presence and excretion in increased amount is associated with many phenomena, all morbid, both of body and mind, and notably with headaches, melancholia, depression of spirits, epilepsy, and, in general, with a lowered tone of consciousness. Normally the cells of the body excrete their waste products as the harmless body, urea. When, instead of producing urea, they produce uric acid, as is normal among serpents, for example, the result is a set of changes of a most far-reaching character, which tend to vary with irregularities in the output of uric acid. In a sense, *there is an attempt at reversion to the cold-blooded type.* And the discrepancy is felt by the mind giving rise to the associated mental phenomena."

The serpent's hate, the peacock's vanity, the baboon's lust, these are reversions if found in man, and yielding to them as mental emotions will actually induce bodily reversions towards those lower types of being from which we have escaped upward; and to return even partially towards such

lower types means for us weakness, illness, death. This is the "inwardness" of Tennyson's verse when he wrote.—

> Arise and fly
> The reeling faun, the sensual feast;
> Move upward, working out the beast,
> And let the ape and tiger die.

In conclusion, I may say that this disquisition on the influence of the mind over the body may be thought to be out of place in an address mostly on anthropology. I do not consider it to be so. If by the study of man we only mean the annotation and indexing into records of what men have done and are doing in the world, such a study does not reach the border of that high land on which true science dwells. For scientia means knowledge, and the highest knowledge must be the knowledge of our true selves, of the inner man, not of the action and interaction of barbarism and culture on the human race. The observation that teaches us properly to "know," and by its help to set ourselves on a higher plane of thought, is observation well bestowed and time well spent.

Art. LXIV.—*Congenital Stigmata.*

By Edward Tregear.

[Read before the Wellington Philosophical Society, 20th April, 1898.]

Plate LVIII.

The subject of congenital stigmata as a race distinction has been lately brought before scientists in France by Dr. J. J. Matignon, and confirmed by the observations of other medical men who have practised among the Mongols and other allied peoples. It may be of interest to start inquiry among anthropologists resident in the Pacific Islands, because assertions are sometimes made that an invasion of men of Mongolian blood has been made at certain times and into widely separated localities of Oceania. If it is found that any of these ethnical birth-marks can be traced among the natives of islands supposed to have been occupied by races of Chinese or Japanese affinity, it might assist us to trace the evidence of such racial occupation.

Chinese children have frequently been noticed as having dark marks, more or less deep in colour, upon the lumbar region. Chinese doctors affirm that these marks are almost

invariably to be found upon children of tender age. The marks disappear on most of the children about the age of four years, but on a few not until they are ten or twelve. Most of the observations have hitherto been made upon infants brought to the hospitals for medical attendance, or left at the orphanages established by religious persons.

The marks appear to be independent of sex; they are found on boys and girls alike. They present the following appearance: The colour is variable; sometimes greyish; sometimes black or bluish-black; sometimes of different colours, like that of a healing bruise. The colour often varies according to the age of the child, being deepest when the infant is newly born, and growing lighter with years. The shapes of the stigmata are uncertain, but their outlines are generally rounded off, and the dimensions are equally variable, sometimes being only of the size of a sixpence, while in other cases it may be as large as the palms of the two hands. The size also varies with age, the surface of the patch gradually diminishing inwards from the exterior boundaries. Some of these marks have been seen that in the first few months of life covered the back of both thighs and the whole lumbar region. Parts of these blotches may remain black while others are getting greyish in process of disappearance, whilst in others different colours are mingled so that it looks like a pattern of mosaic. These spots are not raised in relief above the adjoining surface of the skin, although certain of the very small and very dark places appear slightly raised, as though such a mark was a *nœvus;* but this raising of the discoloured portion is less sensible to the finger than to the eye. The spots often escape observation if not particularly looked for, because Chinese babies are thickly encrusted with dirt; but in doubtful cases it is advisable to press the suspected part, which becomes white when the blood is expelled, and allows the tints of greenish-yellow to appear.

The marks are absorbed by the blood, just as the extravasated blood in a black eye is absorbed.

These marks appear as a racial characteristic—viz., of congenital and transitory stigmata—in the Chinese people; but Dr. Nokagawa, the doctor of the Japanese Legation in Pekin, states that the same markings are visible upon infant Japanese. The Ainos, the aboriginal inhabitants of Japan, do not present the dark-blue mark which is to be found on Japanese children. The people that inhabit the interior of the larger Philippine Islands—that is to say, the aborigines driven into the mountains and forests by the tribes at present in occupation of the coastal portions—appear also to have this mark. Whatever the origin may be of the Negritos, the Igarotes, the Tinguanes, the Burik, the Ifuagos, the Guinanes,

the Itetepanes, and the Gaddanes—all aborigines of the Philippines—their children are born with a patch of dark colour on the loins, which, as they advance to mature age, disappears.

I think it would be worth the while of explorers and scientists, particularly in Micronesia and Melanesia, to make further inquiries into the question as to the birth-marks peculiar to certain tribes, if such marks exist. It may be a much more subtle witness of race-origin or race-crossing than colour of the general skin or hair-texture, and may some day help to throw the light into a dark place.

Art. LXV.—*The Art of the Whare Pora: Notes on the Clothing of the Ancient Maori, their Knowledge of preparing, dyeing, and weaving Various Fibres, together with some Account of Dress and Ornaments, and the Ancient Ceremonies and Superstitions of the Whare Pora.*

By Elsdon Best.

[*Read before the Auckland Institute, 10th October, 1898.*]

The following notes on the above subject have been collected from one tribe alone—viz., from Tuhoe, of the Urewera country. They therefore embody only such information as the elderly people of that ancient tribe have preserved of the art of the *whare pora* of Tuhoe Land in pre-pakeha days, together with a brief and imperfect account of divers strange customs and ceremonies pertaining to the art of weaving, as practised by the old-time Maori.

It would appear that in former times the Maori was by no means the cultureless savage that some would have us believe. The youthful Maori, male or female, passed through a regular education in the days of yore, even as does the Teuton of our advanced culture stage, though necessarily of a different nature. When the stalwart sea-rovers of old colonised these islands they found that their lives must here be lived under somewhat harder conditions than those which prevailed in the isles of the Sunlit Sea. This fact would naturally tend towards stimulating their inventive faculties, and rendering the race mentally and physically stronger.

More especially would this be the case in regard to clothing. The pleasant, sun-wrapped isles of Polynesia called for no more warm or durable garment than those formed from the

bark fibre of the *aute*, but the more rigorous climate of New Zealand demanded something better. Doubtless this was the reason why the culture of the *aute*, or paper-mulberry, was almost abandoned here, the fibre thereof being in later times merely used to construct flying-kites, or as covering for the symbol of an *atua* (god).

Thus the Polynesian migrant would turn his attention to searching for a stronger and more lasting material with which to clothe himself. This he found in the fibres of the *harakeke* (*Phormium tenax*), the *toi* (*Cordyline indivisa*), and *kiekie* (*Freycinetia banksii*). These he utilised, and, as time passed on, there came the knowledge of how to prepare and weave these fibres into suitable garments. And although but a hand-weaver, yet has the Maori acquired the art of making cloaks and other articles of a very close, neat, and durable nature. Many of their finer cloaks were very beautiful, and Maori weaving must not be judged by the articles made by them for sale to Europeans.

I was fortunate in finding here in Tuhoe Land some of the elder people who yet retain much of this interesting and ancient knowledge of the art of weaving, and also in inducing them to weave in the old style some of the garments of bygone days, that the same may be placed in various museums in the colony, and thus conserving, by these various illustrations, the knowledge of this art as it was taught in the *whare pora* of old.

In the realm of Tuhoe every important village possessed certain houses which were specially built for, and devoted to, the study and prosecution of various matters important to the Maori. We will give the names of these, and purposes for which they were used:—

The *Whare Maire*, or *Whare Takiura.*—This was a sacred house set apart for the teaching of the ancient history, genealogies, religion, &c., of the tribe. It was the head university and Herald's College of the district.

The *Whare Mata.*—This house was devoted to Tane, god of forests. In it was taught and carried on the manufacture of snares, traps, and other devices for the taking of birds; also certain rites pertaining to such matters were here performed.

The *Whare Tapere.*—This was the house of pleasure, where the young people of the village met at night to play the various games of old. It was devoted solely to amusement, the allurements of the *rehia.** The presiding deities of this house were Takataka-putea and Marere-o-tonga, who were the parents or inventors of all games.

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* *Rehia* = pleasure, amusement. An ancient term.

The *Whare Pora.*—This was the house specially set aside for teaching the art of weaving in its various branches, and in it were performed the ceremonies connected with the installation and teaching of the *tauira*, or students.

It will thus be observed that the above houses were schools for the teaching of various subjects; but they were also something more, for the various labours, rites, &c., pertaining to such subjects were continually carried on in these ancient colleges by the elder members of the tribe.

There are other *whare* of a special nature, and which are often mentioned in the unwritten archives of Tuhoe Land, but they were not schools in any sense. The *whare potae*, or *whare taua*, was the house of mourning, but in many cases the term was merely a figurative one, and used much as we use it. An expression of a still less literal nature is "*te whare o te riri*"—*i.e.*, "the house of war." The *whare kahu* was a rude hut, often specially constructed for the purpose, occupied by women during confinement. When the infant was about two nights old, mother and child were transferred to the *whare kohanga*, or nest house. But to return to the *whare pora*.

We will now endeavour to give some idea of the initiation of a student in the *whare pora*, having fortunately been able to obtain the information from one who has been through the ceremonies.

When a young woman is desirous of entering the *whare pora* in order to be taught the various arts pertaining to the manufacture of clothing she first obtains the services of a *tohunga* (priest or wise man). It is not necessary that he should be a *tohunga* of high rank, but he must be acquainted with the rites and *karakia* (invocations, incantations, or ritual) of the *whare pora*. She will then say to the *mohio* (person of knowledge), "*Puhatia ake ahau ki to maramara, he hiahia noku.*" A strange expression this, and one which applies to a peculiar custom, as we shall see anon.

The *tohunga* and the *tauira* (pupil) are alone in the *whare pora;* no others may be admitted. The pupil seats herself before the *turuturu:* these are two sticks about 1 in. in diameter and 4 ft. in length; they are stuck in the ground some distance apart, according to the width of the garment to be woven; the upper ends of the sticks often rest against the roof near the walls of the house. This is all the frame used by the Maori weaver—these upright sticks—though in weaving such cloaks as *korowai* four *turuturu* are used. To these sticks is attached the *tawhiu*, which is the first *aho*, or woof-thread. The *tawhiu* is pulled taut and secured, and then to it are attached one end of the *io*, or warp-threads (known as "*whengu*" among some tribes), which *io* are thus suspended

from the *tawhiu*, and hang down to the floor of the house. Thus the work is held or supported by the *tawhiu* and braced by the *turuturu*. The cross-threads, or woof (*aho*), are woven from left to right across the frame. Each *aho* is composed of four twisted threads (*miro*). Two of these are passed on either side of each *io*, being woven in and out, over and under, in a very dexterous manner, and forming, if the *aho* are not too far apart, a very close, neat, and strong garment.

The first *aho* to be woven next the *tawhiu* is the *aho tapu*, or sacred woof-thread. It is imbued with the sacredness of the house, the weaver, and the various ceremonies.

But the *tohunga* and the *tauira* are waiting for us. She is seated before the *turuturu*. The right-hand one is the sacred *turuturu ;* the left-hand one is *noa* (common, devoid of *tapu*), and is known as "Rua."* Before the pupil are spread out or suspended various garments of a fine design, woven by a master-hand in fine patterns of dyed fibre. It is desired that the pupil may be taught to do such fine work as that before her; that the knowledge, taste, dexterity, and power be forced into her during one lesson, as it were, and not drawn out through a long series of lessons, extending maybe over a considerable period of time, as is the case with the benighted *pakeha*. You may imagine this to be an impossibility. Not so : the gods who live for ever can accomplish it.

The pupil takes in her hand some prepared fibre, and holds it while the *tohunga* is reciting the *karakia*, known as "*Moremore puwha*" :—

HE MOREMORE PUWHA.

(E poua ana tena i te tangata.)

Poua mai te pou, ko te pou-e
Ko whakahihiri, ko whakahohoro
Tu-mata-ihi, Tu-mata-whare
Tukua mai te aho kia kawitiwiti
Kia taia hohoro mo te oti wawe
Wawe ki runga, wawe ki raro
Wawe ki te oti o te hikuhiku
Oti tatahi, oti ki te whare
Ruru te puke
Puki-i-ahua, Puke-i-apoa
Apoa ki te rangi
Whanui ki te whenua
E oti. E oti-e.

As the *tohunga* finishes the *karakia* the pupil stoops forward and bites the upper part of the sacred *turuturu*—*i.e.*, the right-hand one. She then takes the prepared fibre she has been holding, and weaves the *aho tapu* across the frame. She has now woven the sacred woof, and come under the influence

* The name of Rua is also applied to the *aho tapu*.

of the priestly invocations. She has entered the *whare pora*. She is a daughter of Rua and Hine-ngaroa.

The next item is the ceremony of *whakanoa*, which is to take the *tapu* off the pupil, her work, and surroundings. This is known as the *hurihanga takapau* (the turning of the *takapau*, or floor-mat): but this is purely a figurative expression; it means the lifting of the *tapu*, the *tapu* itself is the *takapau*. This important invocation having been repeated by the priest or elder, the pupil takes up the *puwha* and eats it, or merely places it to her lips and hands it to the *tohunga* to eat.

Some authorities state that the *puwha* is placed upon the garment which the pupil proposes to copy in her work, from which she takes it at the time when it is to be eaten, that the desired pattern may be clear to her, and thoroughly understood.

Another *karakia* used in the above rite was known as a "*pou*." It was to force home the newly acquired knowledge, and render it firm and lasting. In all such initiations, whether of the *whare pora*, the *whare maire*, or *whare mata*, the first task of the priest was to recite an invocation to render the pupil clear-headed and quick to grasp the new knowledge, to endow him or her with a receptive mind and retentive memory. A similar ceremony was performed over warriors about to engage in a fight, to make them observant, clear-minded, and brave—in a word, to ward off the horrors of the *pahunu*, the *hinapo*, and the *parahuhu*, which ever appear in the train of Tu-mata-rehurehu, of dread memory.

We will now give another description of the above ceremony, with additional *karakia*, as supplied by that fine old patriarch, Tu-takanga-hau, of Maungapohatu, for to him and Paitini, of Ngati-tawhaki, am I indebted for my being initiated into the mysteries of the *whare pora*:—

Ki te puta te whakaaro a tetehi tangata ki tana tamaiti, ki tana mokopuna ranei, hai pupuru i nga korero, i nga whakairo rakau ranei, whakairo tangata ranei, whakairo kakahu ranei, katahi ka mahia e ia tetehi mea hai whakamaunga mana mo taua mahi, ki tana tamaiti, ki tana mokopuna ranei. Ko te kupu tuatahi:—

Ka ma Rua, ka ma Rua-ki-te-hihiri
Ka ma Rua-i-te-rarama
Ka ma taku hau tu, ka ma taku hau korero
Ka ma taku hau i taea e te ata hapara.

Ka mutu enei, ma Rua ena e kai. Ko Rua tona aria he rakau Katahi ka tangohia ko te puwha. Ko nga kupu enei:—

Te umu tirama nuku, tirama rangi
Ko koe, koi wetekia noatia e koe
Whiwhi ou ngakau, ou tangata
Kia puta ki te wai ao
Ki te ao marama.

Tena te umu
Te umu ka eke, te umu kai a koe
Na te umu o enei korero
Ka ma nga koromatua
Ka ma hoki tenei tauira.

Ka kainga te puwha e te tangata, ara e te tauira. Katahi ka poua ki te karakia :—

He Pou
Pou hihiri, pou rarama
Tiaho i roto, marama i roto
Wananga i roto, marama i roto
Tena te pou, te pou ka eke
Te pou kai a koe na
Ko te pou o enei korero.

Then, striking the side of the house, the *tohunga* repeats :—

Ka pa ki tua, ka pa ki waho
Ka pa ki te whare
He wahanga nuku, he wahanga rangi.

Heoti ano, kua noa, kua puta te tauira kai waho.

After the pupil has woven the *aho tapu* she will probably weave in more woof-threads beneath, and thus make a band of some few inches in depth, copying the work of the garment spread before her; but this is never worn, nor even completed in the form of any garment; it is her "pattern piece" (*mea tauira*). When the ceremony of the *hurihanga takapau* is over the *tapu* is lifted from the participants, and the pupil may now leave the *whare pora* and partake of food.

The custom described above, of repeating invocations in order to make a person receptive and clear-headed, was one that called for action at a remarkably early period of life. When the *iho*, or umbilical cord, of a child is severed, and the end thrust back, a priest recites certain *karakia* to cause the *marama* (clearness) to enter and abide in the child; to cultivate the perceptive faculties, that it may be possessed of a quick understanding; and also to cause all *pouritanga* (darkness, sluggishness of intellect) to be cast out with the severed *pito*. These *karakia whakamarama*, together with the *pou* invocation, had a strong and satisfactory effect on Maori students of old, for, whether they were passing through the *whare pora*, *whare takiura*, or *whare mata*, they were thus, by Divine aid, enabled to assimilate and retain all matter, through hearing or observation, in one lesson—that is to say, no repetition of a lesson was ever necessary. Genealogies and *karakia* of a truly alarming length were repeated but once in the *whare maire*. Those who have passed through the *whare pora* will, if shown a new pattern of weaving, faithfully reproduce that pattern on the first trial. Should the weaver but obey the rules of the *whare pora* she can make no error. The gods are behind her. I obtained a short while since a rather in-

tricate but handsome pattern for the ornamental border (*taniko*) of a *maro-kopua*, which I wished to have reproduced. I therefore sent for the old lady who is chief *ruwahine* of the decaying *whare pora* of Rua-tahuna, and requested her to weave me such a one. The pattern was new to her, but she sat down and studied it for about half an hour. She then departed, with a promise to complete the order, but with no request to be allowed to take the pattern. She finished the piece to perfection, it being an exact counterpart of the pattern. The only error she made was, I grieve to state, caused by myself. I stopped at the *kainga* one day to see how my *taniko* was progressing, and foolishly continued to smoke as I sat in the weaving-house. Of course, there could be but one result from such a godless and impious act. A mistake was at once made in the pattern of the weaving, and I was requested to leave forthwith.

The term "*pou*" is applied to the *karakia* given, but it is also used as a verb. Old Whatu, speaking of his wife's knowledge of weaving, said, "*Kua poua e au taku wahine ki tenei mahi, kua whangaia ki te puwha, kua karakiatia.*" She was therefore supposed to be able to do anything in that line.

The above ceremony would also appear to have the effect of rendering a person energetic at the work taught. An old man said in my hearing, "Of a woman indolent at weaving it is said, '*Ko tenei tamaiti, kaore i poua e ona matua*' (she was never *poua* by her parents)."

The *puwha* (sometimes "*puha*") used in this ceremony has been the source of much tribulation to me. Some assert that it is the common edible *puwha* that is used; others that the term is applied to the *kohukohu* and other small plants. Yet again I have been informed that it is a generic term for whatever sacred food is used in the ceremony, and that its use is to cause the pupil to retain the knowledge imparted to him or her, and to assist the *pou* invocation in driving home the lesson. This *puwha* is also used in other *whakanoa* ceremonies, when it is eaten by the *ruwahine* employed to take the *tapu* off. Also, when a priest is reciting the invocation known as "*takutaku*" over a sick person, in order to cause the evil spirit assailing such person to leave him, that priest takes a piece of the long-leaved *puwha* and passes it under or round (*tapeka*) the left thigh of the invalid, and then across his body—*hai ara mo te mate, kia puta ki waho*—as a path by which the affliction or evil spirit may leave him.* On this same subject another authority states that when the *takutaku*

* After which the priest throws or waves (*poi*) the *puwha* towards the heavens.

was repeated a young leaf or shoot of flax was laid across the body of the invalid as a pathway for the *atua* which was supposed to be gnawing at the vitals of the *haura* (invalid), after which the *tapu* was taken off by the *horohoro* ceremony, into which entered the *puwha*, wrapped around a piece of cinder (*ngarahu ahi mate*).

Going back to the *tauira*, old Ngahoro, of Ngatimahanga, says, "*Ka moremore puwhatia te tauira, ka whangaia ki a ia*"—the priest wraps a piece of *puwha* round a small stone and repeats his invocation over it. He then holds it to the mouth of the pupil (*tauira*), who simply bites the *puwha*, but does not eat it. The priest then takes the stone to the *tuahu*, or sacred place of the village, and there leaves it. The pupil will then be able to learn his tasks, and retain anything shown or repeated to him but once (*kua marama a roto*). A similar ceremony was held over a pupil in the school for wood-carving. In these degenerate days the *puwha* is replaced, I regret to state, by the common domestic pipe. So much for the *Moremore puwha* and its uses.

We have mentioned one Rua as a kind of tutelary deity of the *whare pora*. One of the *turuturu* is named after him. The name is also applied to the house-post on which the *maro* is suspended at the time of the *kawa* ceremony. At some remote period in the history of this ancient tribe of Tuhoe, or of the people from whom they sprang, there has flourished a popular hero chief or wise man of this name. Rua is probably a deified ancestor, and the name enters largely into the mythology and sacred lore of Tuhoe Land, usually under the forms Rua-te-hihiri and Rua-te-pupuke. A member of the Ngatiawa Tribe—H. Tikitu, of the Pahipoto *hapu* (sub-tribe)—told me that Rua-te-pupuke was the originator of *whakairo*, a term which is applied not only to wood-carving, but also to tattooing and the weaving of coloured patterns in cloaks, &c. He states that on a cliff near Te Kaokao-roa, at no great distance from Te Awa-a-te-atua, are incised all the known patterns of *whakairo*. They were engraved thereupon by the gods of old, and from those patterns the old-time Maoris derived their knowledge of *whakairo*. A strange story this, and an interesting one when we reflect upon the fact that the art of wood-carving as practised by the Maori of New Zealand appears to be a home production. Again, it is said that Te Tini-o-te-Hakuturi, a tribe of wood-elves of far Hawaiki, taught Rua the art of wood-carving, and that he obtained patterns or designs from spiders' webs. Others state that Rua-te-para-kore and Rua-te-kuka were the fathers or originators of carving. The former said, "Let all dust and small chips be carefully cleaned out of all wood-carvings." "Not so," replied Rua-

te-kuka; "let them remain, that the red-ochre paint may adhere." Whoever the original Rua may have been, it is more than probable that he was a denizen of the Hawaikian fatherland. It is here worthy of note that Tahiti would appear to be known to the Maori of New Zealand as Tawhiti-nui-a-Rua. Among my notes on Rua I find the following: Rua-te-pupuke was asked to go fishing. He replied, "*Na wai te kokomuka-tu-tara-whare i kiia kia haere?*" (Who says that the *kokomuka* growing on the house-walls should go abroad?) The *kokomuka-tu-tara-whare* is a species of *Veronica* which is often seen growing upon the earth-covered *whare puni* of this land. The aged Rua meant to imply that he was too old to go a-fishing; he had grown to the walls of his house. This term is often applied to people of a stay-at-home nature. Also Te Tini-o-te-kokomuka-tu-tara-whare is said to have been the name of one of the ancient tribes of this region.

The following is a fragment taken from one of my note-books, and presumably a portion of a *karakia*:—

Rua te pupuke, Rua te hotahota
Takoto te ika whenua i te rangi
Katahi ka uraki mai
Ki te whanau o te manumanu kikino
Ki te Aitanga a Punga i au-e.

And again, in an ancient *tangi* or lament for one Rangi-uia, a famous ancestor of the East Coast:—

Whiti tuatoru.

Ko wai ra e hika
To mata i haere ai koe ki te Po
Ko Turanga wahine, ko Turanga tane
Te mata tena o to tupuna
O te Ao-ariki i te Manu tukutuku
Ka hinga tona puta ko Wai-o tira-e
I oma atu ra kia Papa raia
I hurihia atu ra e Tane ki raro
Ka puta atu ki waho ko Ruau-moko-e
Tarewa i tona puta ko te Raukape ra
Ko Tama-reo-rangi ka kume i a Tini
E waitohu ake ki te ao marama
Ka ngarue te whenua, ka ngaoko te moana
Ko te tumu o te rangi, ko te take o te rangi
Ko Maru-i-tauira, ko Maru-i-torohanga
Ko Maru-i-taura, ko Maru-i-tawai
Ko Maru-i-taketake, ko Maru-whakatupua
Ka ea ki runga ra
Ko te Tumoremore, ko te Tuhaha
Ko Rua-kapanga-e, Te Manu-nui ra
Ko Rua-te-hohonu, ko U-wawe-ki-uta
Ko Manawa-pou-e
Ko Kourunga ra, ko Tu-mauri-rere
Me ko Rongo-whakaata, ko Rongomai-hi-kau
Ko Rua-whetuki-e
Ko Hitamu rira, ko Turourou ra
Ko te Ika whakatu ki roto o Turanga.

Here Rua-te-hohonu appears in a connected genealogy, as has been proved by independent evidence. When Poura-ngahua went from Turanga (Poverty Bay) to Hawaiki he there obtained the *kumara*, and it is said to have been Rua who lent him the Manu-nui of Rua-kapanga as a means of bringing the *kumara* to New Zealand. This occurred at Ahuahu-te-rangi, at Hawaiki. One account states that it was to bring the Kura-o-tai-ninihi here, but this may be simply a term for the prized *kumara*. As for the Manu-nui, my informant says, "*Ko Tane taua manu*" (that bird was Tane), but whether in the form of a bird or a canoe I know not.

Te Whatu, of Tuhoe, says, "Mata-ora was an ancestor of the very remote past. He it was who first taught the art of boring or piercing (*poka*) in wood-carving. His knowledge descended to Rua."

In a lament composed by Ranga-ika for his son, who was slain by Moko-nui-a-rangi, we find:—

Kati ra E hika
Te takoto i raro o Papa-tahua-roa
E ara ki runga ra. E mau ki to toki
Haua atu ra ki te Riu o Tane
E mau ki to patupatu hai tono kai mau i te ata
Nga mahi E hika ! Na Rua-te-pupuke
Na Rua-te-hotahota, na Hine-ngaroa
Ra mahue i a koe
Ka puta mai te karere i a te whare kahu ra
Ka pae Ngati-ngahere, he homai i te huia
He homai kakahu i te remu ngorengore
I te wai whinau, te Whatu o Poutini
Hai kawe i a koe ki te unahi o te Ika o Pararaki
Ki te awe mahiti mo Te Whata-angaanga
Ko te upoko ra E Waru-kai-tutae !
E Hongi-kai-hamuti ! E Nini-ngau-tara
Ko taku ai pahu ra
Hai kohu manu ki Whitikawa raia
Mo te tai ruru-e, ki te pu whakatangi
Mau e ui mai mo te ara i whea mo te tamaiti-e
Ka riro nei i a koe
Taku waka to kau, he pitau whakarei
Taku waka whakatekateka.
Ki te tau o te wai-e.

This Hine-ngaroa here mentioned is said to have been a famous ancestress of the misty past, and who was a contemporary of Rua. She taught the art of weaving baskets and sleeping-mats in coloured patterns. It is probable this name is a form of Hinganga-roa, who is here said to have been a child of Houmea-taumata and Tautu-porangi of wondrous fame. Houmea was probably of this region, inasmuch as a small pond on the summit of Huia-rau is known as Te Puna-a-Houmea, while Te Toka-a-Houmea is a huge rock situated in a paddock and near the roadside about a mile from Whaka-

tane Township, on the road to Rua-toki. In White's "Ancient History of the Maori" (vol. 2, p. 163) it is stated that Hinganga-roa built the first carved house from patterns obtained by Rua from Tangaroa (the Polynesian Neptune). The story of Rua and Tangaroa-a-whatu as retained by Tuhoe is of great interest.

Of the origin of the art of weaving, H. T. Pio, of Ngatiawa, says, "The first of our ancestors to understand the art of weaving clothing was Hine-rauamoa, who was the wife of Tane-nui-a-rangi. She wove the garments known as *kuaira, tawhiri, maro-waiapu, huna,* and *tawhara-nui.** That was the commencement of weaving among men, and the knowledge of weaving and ornamenting cloaks increased as time passed on." Among these ancient garments Pio mentions *te kiri o Tane,* or tree-bark. This may possibly be a reference to the *aute* of Polynesia.

Of the *kuaira,* Pio says, "*He huruhuru no tetahi iwi no mua noa atu o Mataora. He huruhuru manu pea. Ka mahia hai kakahu.*" The *kuaira* was (made of) the *huruhuru* (hair, fur, or feathers) of a very ancient tribe of remote times, of the realm of Mataora. It may have been feathers of birds. It was used for clothing. In Tregear's dictionary "*kuara*" is given as a sandal.

While passing through the ceremonies described above, as also those pertaining to the *whare maire,* &c., the novice is not allowed to partake of food, nor even to approach any place where food is cooked, kept, or eaten; nor may the pupil have any communication with his or her family. Should the rites or lesson not be completed during the first day, then the pupil must either sleep in the *whare* where the initiation takes place or else go off and sleep by himself somewhere outside. Wherever he may sleep, he and his sleeping-place are *tapu.* Not until after the *tapu* is taken off may the pupil eat food or retire to his own domestic circle.

After the flax-fibre has been obtained from the leaf by a scraping, or, rather, stripping, process (*hangu,* or *haro*), it is known as *whitau, hitau,* or *muka.* This fibre is then hung up in the sun to bleach, otherwise it will become discoloured (*pango, whero,* or *puwai*). For the finer class of cloaks, kilts, &c., it is then put through a beating process. The operator takes a hank of the fibre, and, placing it on a stone, beats it with a stone club (*patu hitau*). This makes the fibre very soft, and tends to bleach it. Fibre intended for the *io* (warp) is thus treated until quite soft (*ngakungaku*), but not so that intended for *aho* (woof-threads). The *patu,* or stone club, is about 10 in. long, and is well formed, being as symmetrical as

* *Tawhara-nui* = a garment of *kiekie* fibre.

a war-club, though not polished. They were made of hard volcanic stone (*karā* or *uri*), the rough grain of that stone being preferred. A piece of quartz was lashed to a handle, and with this crude implement the club was chipped into form, albeit a long and tedious process. A good *patu* was much prized by weavers, and was handed down for many generations. The *patu* of the hard maire wood were too smooth to be appreciated for the above work, but were used for pounding fern-root, and some for pounding bark for dyeing.

Two kinds of threads are used in weaving—namely, *miro* and *karure*. The *miro* is simply a piece of fibre twisted by being rolled under the hand. The fibre is placed across the leg just above the knee, and held by the left hand. The right hand is placed upon it and thrust outwards, thus rolling and twisting the fibre beneath it. This movement is termed a "*maui*." The same movement is then repeated, but backwards—*i.e.*, towards the body. This is called a "*katau*." The two rollings complete the process, and the *miro* is complete. This word "*miro*" is used as both verb and noun, as also is the term "*karure*." The *karure* is formed by twisting two *miro* together, the result being a very strong thread. The thrums for *korowai*, &c., are usually *karure*.

Tihoi: This term is applied to short *aho* (woof-threads) woven into the centre of cloaks, *maro*, &c., in order to widen the centre, and give them a rounded form, that they may fit better. It is equivalent to the *mata-whiti*, or skipped mesh, in netting. The *tihoi* cross-threads do not extend to the edges (*tapa*) of the garment.

Tāmĭ: This word is applied to the *tihoi*, to denote completion. *Kua tami te tihoi*—that is, the short *aho* are completed.

Kamo: To close or finish off a pattern in *taniko* (ornamental border to a cloak or kilt, woven in patterns with different-coloured threads) is expressed by the term "*kamo*." In weaving the diamond pattern, when a diamond is finished off at the lowest point it is "*kua kamo*."

Tăuă: This expression is applied to commencing the weaving of a garment. It is an ancient word, and applies only to weaving. Thus the *aho tapu* is known as the *aho tauatanga* (= *aho timatatanga*), or commencing woof-thread. Also, should I say "*E whatu ana ahau i taku hihi-ma*" (I am weaving my *hihi-ma*) the expression would not be good form; it savours of conceit; people will think that I am very proud of my knowledge of weaving. It is much better to say, "*E taua ana ahau i taku hihi-ma (he kupu whakaiti tena)*"—I am beginning to weave my *hihi-ma*, the same being a fine cloak with white thrums (*hukahuka*). In like manner is the

expression "*karukaru kete*" made use of. Thus, I may say, "I am going to collect my *karukaru kete*." I do not say "my property," lest people should say that I was conceited; but still it has that meaning. Again, in a manuscript book written by my worthy old teacher, H. T. Pio, of the sons of Awa, I find this: "*Ka rewa te taua. Ka ki atu te tangata o te kainga, 'Haere, kia pai te haere. Te karukaru kete kei mahue, te părărū kete kei mahue. Kei piki i mua o te aroaro o te tohunga, te mate o tena he kahupo, kaore e hopu i tetehi karukaru kete, me te mea e matapo ana. E kore rawa e hopu. He hara*'"—"The war-party goes forth. The people say, 'Farewell! Be cautious. Forsake not the *karukaru kete* (take food with you). Forsake not the *părărū kete* (the sacred basket of the priest, in which is carried the *tapu* food for the Taumata and Kete rites before battle), lest ye pass before the person of the priest and be afflicted by the *kahupo*. If so, you will take no *karukaru kete* (loot, or prisoners), but be as one blind. You will take none, because you have sinned.'" However, this is digression.

Kaupapa: This word is applied to the body of a feather cloak. The body or basis or groundwork is woven of dressed flax-fibre, and is termed the "*kaupapa.*" The feathers are inserted as the weaving proceeds, being secured by the *aho*.

Kiri kiore: An expression applied to close, neat weaving, in which the *aho* are very close together. Of neat work in weaving or carving a *mohio* will say, "*Na te rehe.*" This word seems to be applied to a small-handed dexterous person, handy at fine work, and of a quick, nervous temperament, as in "*Ou mahi a te rehe,*" "*He rehe, na te rehe,*" and "*He maikutu tona tukunga iho.*" "*Maikutu*" means meddlesome. Of a child who is continually handling, fingering, or pulling things about we say, "*Ou mahi a te maikutu.*"

Hinarunaru (= *hingarungaru*)*:* This word is used to denote rough, poor weaving; it has a ridgy and uneven appearance. It is also applied to a rough or lumpy sea.

Taheha and *takeka* are words used to describe rough, unsightly weaving.

Hukihuki means unfinished: "*Ko te korowai i tukuna e koe, haere hukihuki ana*" (the *korowai* cloak that you sent goes in an unfinished state).

Ruha is a term given to worn-out fishing-nets, the same being made of *whitau*. They were often utilised as kilts, &c. An old proverb says, "*Ka pu te ruha, ka hao te rangatahi*" (the old net is cast aside when the new one is brought into use), a saying applied to a young person taking up the labours of his aged parents.

Parahuhu: To draw fibre across the thumb-nail in order to scutch it.

Tawewe and *katoatoa* are words used to describe slovenly weaving, the *aho* being too far apart.

Kawitiwiti denotes that the *io* have been spaced too wide.

Whatu: To weave. *Ta:* To net. *Ta* is also an abbreviated form of *tahei* (to set snares for birds on trees).

Some interesting allusions to the art of the *whare pora* and other matters are contained in a lullaby composed by Hautu for her granddaughter, Te Pare-kānga :—

He Oriori.

E hine, e moe nei. Kati ra ko te moe
E ara ki runga ra, e mau ki te hoe
Ko te hoe nui e. Ko te hoe roa-e
Ko te hoe na Mata-hourua i tutu ai i te ata-e
Taia atu ra te tata, te takerepapa ra
Kia mimiti, kia pakora te tai ki Hawaiki—E hine ra.
E hine, hai noho i te taha ki te ahi, hai te koko-pouri
Kia whakarongo to taringa ki te waha o Tane
E ko* i te ata
Ko te tohu o te raumati, E hine
Toia ake ra te tatau, ka titiro ki waho ra
Haea mai ra ko te ata i tua, ko te ata i waho
Ko te ata e whano ai e tu te horopito i raro-e
Kao, ka awatea-e.
Ka hopu ra to ringaringa ki te turuturu
Komau whakaarahia i te putahi
Tuaumutia ra, ka kai Rua-i-te-hihiri
Ka kai Tangaroa me tana whanau wahine
Me Hine-karekare, me Hine-ahu-one
Ko nga wahine ra tena i haere ai
Tapu i ai roa i Hawaiki
E hine ra, taumahatia ra
Tuia a uta, tuia a tai, tuaia i te pito-e
Whatua mai te aho kia kawitiwiti, kia katoatoa
Mo te oti wawe, E hine
Waiho te whare, E hine,
I to tipuna, i a Paia
Hua rawa atu nei, ka matau rawa i a ia
Te whata a to tipuna, a Raumati-ninihanga
Para whetau e
Na Turu-whatu te whata a Pouroa i Tahuna-a-tapu
Mou ra, E hine, koi hikaia koe ki te ahi o te ruhi
Ki te ahi o te ngenge, ki te ahi o te whakamatiti†
Mo te kore rawa, E hine.

Another term to express bad weaving is "*ngekingeki.*" If the *io* do not lie flat, smooth, and regular (*he karawhiti no nga io*) this word is used.

Ngaurăpărăpă: A term applied to *whakairo kakahu.* "*Mo te whakairo a te wahine, kaore i mau te whakairo ki runga ki te tuara, ki te kaki ranei o te kakahu, engari ki nga waewae.*

* *Ko* = an expression used to denote the morning and evening concerts of forest-birds; also known as the "*māra o Tane.*"

† *Ahi whakamatiti* = an incantation to cause the hands of a meddlesome person to shrivel or contract.

'*Kia titiro iho ana e whai ana te ngauraparapa, ehara te wahine kokoti rere i te kakahu.*' *Mo te wahine pakihore, rorirori.*"

Taurekereke : A term applied to the margin or edges (*tăpă*) of cloaks.

Men sometimes entered the *whare pora* as students, and passed through the same ceremonies as women. They generally turned their attention to the *whakairo*—that is, the weaving of ornamental borders in various colours; also to learning to sketch and colour the patterns painted on the rafters of important houses.

Fine cloaks of dressed flax-fibre, such as the *korowai, aronui, paepaeroa, hihi-ma,* &c., and the finer *maro,* are termed *kakahu,* but the rough cloaks, formed of inferior material, and often covered with short pieces (*hukahuka*) of unscraped flax (*harakeke*), never received that name. Still they had distinctive names, as follows: All rough coarse flax cloaks are known by the generic name of "*mai,*" though they include different kinds, such as the *timu* or *whakatipu,* the *pora,* the *manaeka,* the *tatara,* &c.

The rough serviceable cloaks formed from the fibre of the *kiekie* are known as *pākē,* while those made of the fibre of the *toi,* or mountain palm, are styled "*toi.*" A list of the different cloaks, kilts, &c., as manufactured in Tuhoe Land is as follows:—

Kakahu.

Aronui : This fine cloak, now no longer seen, was made from carefully prepared fibre of the best variety of flax. The body of the garment was left the white colour of the bleached fibre, and was without thrums (*hukahuka*). It was a much-prized garment, and worn by leading chiefs alone. It had a wide *taniko,* or border, woven in tasteful patterns of black, white, and red fibre at the bottom, and a similar border, but narrower, at the two sides.

Paepaeroa : This large cloak ranked equal with the *aronui.* It was made of the same material, but had a wide *taniko* at both sides and end. It had no thrums. In weaving the *paepaeroa,* the *taniko,* or ornamental border, was the first part woven, but in the *aronui* it was the last.

Parawai : A large cloak of same material as above. It had no thrums.

Parakiri : Same material. *Taniko* on two sides only; none on lower end (*remu*). A large cloak, with no thrums.

Horihori : Same material. *Taniko* on sides only. No thrums.

Korowai : Same material. A fine large cloak. No *taniko,* but the white ground covered with thrums of fibre dyed black. This garment is still made.

Tahuka: Same material. It resembles a *korowai*, but has no thrums.

Pakipaki: Same material. It is like an *aronui*, with *taniko* on all sides. It has an extra *whakairo* piece woven on to the *taniko*, which piece is termed *pakipaki*; hence name of cloak. *Papaki* means to fasten one thing on another, to sew together. Among Tuhoe the terms "*papai*" and "*rāpā*" are used to denote the sewing of a patch on a garment.

Hihima: Same material, but is entirely white. It has no *taniko* or *whakairo*, and all the thrums are white.

The *taniko*, or ornamental coloured borders, are, as a rule, woven on after the body of the garment is finished. About ten threads are woven at once, all of which are *miro* except two, which are *karure* (double threads). These *karure* are termed the "*ngakau*," and are used to prevent the piece being woven from puckering or becoming irregular (*hinarunaru*). They are frequently pulled by the weaver, to keep the work straight and even. Names of famous weavers are long remembered. Should a *koeke* (elder) be watching my *ruwahine* weaving *taniko*, he will say, "*Whakairo ana a Te Waha-mu*" (Te Waha-mu is weaving), the latter being the name of her great grandmother, a famous weaver.

The above given were the swell cloaks of Tuhoe Land—that is, of the flax garments; but we yet have the feather cloaks to deal with, many of which were particularly striking. No cloaks have the *taniko* in centre or on the body of the garment, nor yet on upper end.

In making feather cloaks the ground (*kaupapa*) was woven of flax-fibre as in making a *korowai*, the feathers being inserted in regular rows, and bound by the *aho* as the work proceeded. The feathers were secured so as to overlap, and in a well-made cloak were almost as smooth, regular, and even as the plumage of a bird. Very beautiful is a well-made feather cloak, inasmuch as the various coloured feathers are often worked in regular and tasteful patterns. Again, some are white with a deep border of black feathers, others in squares of black and white. A fine one in my possession is worked in small triangles of black and white alternately, the edges of each figure being marked by a row of red feathers of the *kaka*. The cloak is a very handsome one, and was presented to me as an *oha* by the Tama-kai-moana *hapu* of Maunga-pohatu.

These feather cloaks are known as *kakahu kura* or *huruhuru*. When made wholly of the feathers of one species of bird they received such names as *kahu kiwi*, *kakahu kakapo*, *kahu kereru*, &c. Some fine feather cloaks are yet made in this district.

Mai.

Timu, or *Whakatipu:* This is a rough, strong, and serviceable cloak (as, indeed, are all *mai* and *pākē*) worn over the shoulders. They are not long trailing cloaks like the *kakahu*, already described, which are often as large as a single blanket. The *mai*, *pake*, *toi*, and *kiekie* might be described as capes. They are tied with a cord, and are so constructed as to turn rain well.

The *timu* is woven of the coarser varieties of flax, and is covered with short pieces of undressed flax about ¾ in. wide, which lap over each other, and turn rain as a shingled roof does. The strips of undressed flax (*harakeke*) are about 6 in. long, and are scraped for about 1 in. in the centre, to enable them to be bent easily and lie flat on the body of the cape. They are inserted under the *aho* (cross-threads) as the garment is being made, being held by the *aho* in the centre, the two ends hanging down over the *kaupapa*, or body of cape. On the top of the cape is a thick twist of undyed *whitau*, which is the *whiri* (collar). Interwoven with the *whiri* is a cord of fibre dyed black, the ends of which hang down at either end and are used to tie the cape. These capes are about 4 ft. by 3 ft.

Manaeka (= *mangaeka*) *:* This is a species of *timu*, but is somewhat more showy, as the strips of *harakeke* (*hukahuka*) covering it are dyed in various colours. A *manaeka* in my possession is of three colours, the covering-strips being in black, brown, and yellow. The black and brown are arranged in vertical bands about 4 in. wide, while the yellow strips are attached in bunches of four each, set at intervals; also five bunches of ten each are attached to the *whiri*, or collar. *Manaeka* (the elided "g" is a peculiarity of the Mataatua dialect) is the name of the yellow *hukahuka*, or strips; hence the name of cloak. "*Ka manaekatia te whakatipu*" is said of inserting these yellow *hukahuka*. The word "*whakaewaewa*" bears the same meaning as "*manaeka.*" These yellow thrums (*hukahuka*), known as "*manaeka,*" are so coloured by being scraped (*hanunu*. Cf. *hangu* = *hāro*) by means of a shell (*kuku*), and heated before a mass of glowing embers.

Pukaha, or *Pureke:* This is a very rough cape of inferior *whitau*.

Pora, or *Tuapora:* A rough cape of *harakeke*.* Used as a generic term.

Tatara: A cape of *whitau* ground covered outside with

* Rough shoulder cloaks and capes were also made of the fibre of the leaves of the *ti* or cabbage-tree, the dead leaves (*kuka*) of which were used as *aho* and *hukahuka*.

short *hukahuka* of dried and curled *harakeke* (undressed flax), which rattle as the wearer moves.

Tihetihe: Resembles a *timu.*

Pauku, or *Pukupuku:* A thick mat-like cloak, very closely woven, and worn in battle as a defence against spear-thrusts. Before entering into a fight these *pauku* were soaked in water, which caused the fibre to swell, thus rendering it a very fair shield. A warrior would wear two of these mats, thus protecting his body against the thrust of *huata*, or *tokotoko*, and the impact of the *tarerarera*, a rude spear thrown by means of a whip.

Pokeka: A rough cloak. Used as a generic term for such.

Pekerere: A shoulder-cape. Some resemble a *pora*, others are closely set outside with thick thrums of coarse, roughly dressed flax, like a *mai.*

Kilts.

Piupiu: This is a kilt made of long strips of green flax, which are scraped about every alternate inch, and dried so that they curl into a round form (*topuku* = cylindrical). They are then dyed. The scraped portions become black, but the unscraped parts remain almost the natural colour of dried flax. The ends of the strips are scraped and woven into a band 4 in. to 6 in. wide, which passes round the waist, and is tied by cords left at either end. Thus the kilt is really composed of long, loose, detached strips which hang to the knee, but do not interfere with one walking, although they conceal the limbs. It is, in fact, a rational dress, and a picturesque.

Kinikini, or *Pokinikini:* Similar to the *piupiu*, but which rattles as the wearer moves, which the *piupiu* does not.

Rapaki, or *Papaki:* These were kilts made like a *mai*, but smaller, and would turn rain. They are not picturesque.

Kiekie Capes.

Rough but serviceable shoulder-capes were woven from the fibre of the *kiekie*, but, unlike the flax (*Phormium tenax*), the leaves of the *kiekie* had to be put through a retting process. They were steeped in water until only the fibre remained (*kia ngakungaku*), to soften it, which fibre was then worked up.

Toi Capes.

These were very strong and durable shoulder-cloaks, and the fibre of the *toi* or mountain palm (*Cordyline indivisa*) was for centuries the only good material possessed by Tuhoe for the manufacture of clothing. For Nature has frowned upon

that ancient tribe of mountaineers, even from the dim, mist-laden epoch when Te Maunga (the mountain) descended from on high, lured to earth by the fleecy charms of Hine-pukohu-rangi (the Goddess of the Mist), and unto them was born Potiki (the child), from whom sprang Nga-potiki (the children), a tribe now known as Tuhoe and Te Ure-wera. Frowned upon by Dame Nature were these Children of the Mist, for, look you! so inhospitable are those savage ranges of Tuhoe Land that, save for the abundance of birds in their great forests, no man might dwell therein. For the *kumara* and *taro* could not be cultivated; and, as for clothing, no flax grew in the realm of Potiki save the inferior kinds found on cliffs, which were useless. Thus, when the snow and sleet of the *whaturua* (midwinter) drifted down from giant Huiarau, the only salvation for these bushmen were the *wharepuni* and the *toi* cloaks. It is only in recent times that the better kinds of flax have been introduced and cultivated here. It is said that Taitua first introduced the better flax, from Waikato, some six generations ago. The *kiekie* fibre was formerly used by the people of the lower Whakatane and Tauranga Rivers, but it does not grow far inland, the nearest to Rua-tahuna being at Hana-mahihi. In ancient times the leaves of the *mauku* (*Asplenium bulbiferum*) were woven into a sort of rude mat, and a very poor and perishable one it must have been. Hence the old-time sayings for this district: "*Rua-tahuna kakahu mauku,*" and "*Rua-tahuna paku kore.*" These *mauku* mats were worn at night only, being warmed at a fire and used as a covering. They were too perishable to be worn outside. It is thus a fact that in ancient times these mountaineers wore scarcely any covering, and in winter they remained in their semi-subterranean houses.

The *toi* capes are made in the same style as a *timu*. The fibre is much coarser than that of flax, and much resembles in colour and appearance the cocoanut-fibre seen in floor-matting. In making these capes only enough leaves are cut for one day's weaving, for if left longer they cannot be prepared; they become dry, and the vegetable matter cannot be disengaged from the fibre (*ko te para kaore e pahuhu*). The mid-rib (*tuaka*) is taken out of the *toi* leaves, it being too hard to work, after which the leaves are beaten to soften them and disengage the *para* or vegetable matter. These fine leaves are often seen 8 in. wide. The *hukahuka* of this cape are strips of the *toi* leaf, not bruised or beaten, or they would not lie close and flat, but curl up. (*Kaore e pai kia marū a waho, engari kia tupa tonu, kia kaua e kopa.*) The *toi* capes are dyed black when finished, and will remain waterproof for many years. The old dried leaves of the *toi* are termed

"*kuka*"; they are used for the *hukahuka* of the capes (strips same as for *timu*) and for the *aho*. This term "*kuka*," also "*koka*," is applied also to the dry leaves of the *ti* (cabbage-tree), of which, however, there are very few in this region. "*Ou mahi a te tuakoka, kaore he kăkă, he aha, no reira ka kakahu i te kuka ti.*" This term "*tuakoka*" is applied to a poverty-stricken person or place. "*E tuakoka ana te kainga nei*," said of a place where food is scarce.

Kahu Kuri (Dogskin Cloaks).

These were probably the most highly prized of all the ancient cloaks. There is but little information on record anent the old Maori *kuri*. Pio, of Ngatiawa, states that the ancient tribes of New Zealand possessed the dog, it being known as "*kuri ruarangi*." The *kuri* was used for hunting the *kakapo*, *weka*, and *kiwi*, and was also eaten. The tails and skins were used for cloaks, or, rather, to adorn the same, for the body (*papa*, or *kaupapa*) of the cloaks was almost invariably of *whitau*.

Kahu-waero: This was the most highly valued. The cloak was woven of dressed flax, and so thickly covered with white dogs' tails that *papa* of the cloak was quite concealed. The hair of these tails was long, and the tails thick and bushy.

Mahiti: This was of the same materials as the *kahu-waero*, but the tails were not so numerous, being attached at wide intervals.

Puahi: This was made of the skins of white-haired dogs, the skins being cut into strips, and sewn on to the body of the cloak.

Topuni: This was made in the same manner as the *puahi*, but of black skins. This was the least prized of these cloaks; still, all were worn by chiefs only.

Ihupuni: Of similar make to the *topuni*, and of black skins.

Tapahu: A war-cloak of dog-skin. Used as a protection against spear-thrusts. "*He tapahu o Irawaru*" is an ancient saying, Irawaru being the tutelary deity of dogs. This cloak was formed by sewing together the skins of dogs, no flax being used in its contruction.

We have given a list of such cloaks as were used by the natives of this region in former times. These cloaks and capes were all worn across the shoulders, and were fastened either in front or on the right shoulder. The rougher class of such garments were fastened by means of the two strings before mentioned but the finer ones (*kakahu*) were often fastened

by means of cloak-pins, termed "*autui*." These *autui* were slender curved pins, about 4 in. in length, very neatly made of whalebone, and in later times from boars' tusks. A man would often have a bunch of these *autui* suspended to his cloak in front, as an ornament. The *aurei* were small, oblong, flat pieces of whalebone, similar to the *kakara* fastened to a dog's neck when hunting the *kiwi*. Four or six of these *aurei* were fastened to a chief's cloak in front, so as to make a rattling sound as he moved.

Ochre: No Maori chief or exquisite could be happy unless his dressing-case were well supplied with red ochre, red being the colour most esteemed by the Maori. This ochre (*horu*, or *kokowai*) was applied to both the body and the clothing in days of yore. It was mixed with shark-oil, or the oil expressed from the berries of the *titoki*, and thus used as a paint. Lateral bands of this pigment painted across the forehead were considered a great ornament, and were known as "*tuhi korae*," or "*tuhi marae kura*." Bands or stripes of the same crossing the face diagonally from the corner of the forehead down over the eye to the cheek were termed "*tuhi kohuru*." Ochre was either collected from certain springs or by burning certain earth. Famous springs of this kind generally had distinctive names, such as "Nga Toto-o-Tawera," near Ohaua.

Maro.

Shoulder-cloaks, large and small, were the principal clothing of the Maori. Garments wherewith to cover the lower limbs were a secondary consideration. The *rapaki*, or kilt, was usually a small *mai*, or a *piupiu*, as we have seen. Besides these, there were different kinds of *maro* used by both males and females. The *maro* may be described as an apron, being much smaller than a *rapaki* (kilt). Neither did the *maro* extend round the body, but was either drawn between the legs (*ka hurua te maro*), and fastened behind to the belt, or else two *maro* were worn, one in front and one behind (*tau-mua* and *tau-muri*).

Maro-kopua: This was a triangular apron or girdle worn by girls of good family. It was woven of fine dressed flax-fibre, and was adorned with *taniko* and *hukahuka* (thrums). The desired shape in this *maro* was obtained by means of the *tihoi* process.

Maro-waiapu: This was also a woven *maro* ornamented with thrums. It was square in shape, and was worn by chiefs only; never by the ordinary people. It will be remembered that this was one of the garments woven by Hine-rau-a-moa, the inventor of weaving. H. T. Pio gave the genealogy of Hine-rau-a-moa as follows:—

Table showing the Descent of the Earth-dwelling Sons of Man from Chaos through Hine-rau-a-moa.

Te Pu = Te More

Te Weu = Te Aka

Te Rea = Te Wao-nui

Te Kune = Te Whe

Te Kore = Te Po

Rangi = Papa-tuanuku

Tane-nui-a-rangi

Tangotango = Wainui

Te Ra

Te Marama

Nga whetu

Te Hinatore

Te Pari-kiokio

Hine-rau-a-moa = *Tane*

Rongo-matane

Hine-te-iwaiwa

Tangaroa

Tu

Tawhiri-matea

Haumia

Ioio-whenua

Pute-hue = *Tawhira-matea*

Makara = Rotua

Hine-nui-te-po

Mahuika

Hiwa-ki-te-rau

Itiiti = Tawhaki

Whakawatai = Turoua

Kura-ariki = Hine-ata

Te Kura-i-monoa = Toi

Awa-nui-a-rangi = Te Papa-tu-rangi

Awa-morehurehu = Te Pae-rere-i-waho

Irakewa

Toroa

Rua-ihonga

Tahinga-o-te-rangi

Awa nui-a-rangi

Rongo-tangi-awa

Rongo-karae

Marie

Mahuru

Kura-ariki

Tu-whanau-ara

Moenga

Tu-whakamoe

Te Kura

Moko-nui

Tapui

Tu-takanga-hau*

Pinohi

Te Ika-poto.

* The old chief of Maungapohatu.

Maro-waero : This was a prized *maro* worn by chiefs only, and was made as a *kahu-waero*, being adorned with dogs' tails.

Maro kuta : This was a small single *maro*, worn by girls, the *tau* or cord being fastened to the belt behind. The *maro kuta* was made of a species of sedge or coarse swamp-grass known as "*kutakuta*," or "*paopao*." (*He mea takiri, ka paieretia, ka mahia hai maro mo nga wahine.*) Two *aho*, or cross-threads, were woven across the coarse fibrous *paopao* to bind same, the ends hanging loosely down, as in a *piupiu*.

Maro-huka : This is said to have been a *maro* made of flax-fibre. It appears to have been worn only by priests, or during certain rites or ceremonies, as was also the case with *tu-hou*. The *maro-huka* was worn during the war-dance, and was donned by a priest when about to engage in some sacred task. ("*Ka huihui mai nga tohunga ki te tuahu ki te inoi, ka tatua ki te tu-hou, ka maro-huka, ka whakatairangi, ka pakauroha nga ringa.*")

Tu-hou, or *maro-tuhou :* This appears to have been a rude *maro* of leaves of the *karamuramu*, or other shrubs. It was worn by priests during ceremonies of various kinds. It was also known as a "*maro-taua*."

Maro-purua is a term used to denote a married woman.

Tau-maro : This was not a woven *maro*, but merely a bunch of flax-tow or refuse (*hungahunga*) worn by young girls (*hai huna i te aroaro*). Boys wore nothing; not even the proverbial postage-stamp, as a rule.

The term "*maro*" is also applied to certain *karakia*, or invocations, used in war, such as *Te Maro-o-whakatau*.

Tatua and Tu, Belts and Girdles.

The generic term for belts is "*tatua*," but they are of different kinds. The term for belts made of undressed flax is "*tatua whara*." Belts formed of one woven band, whether of dressed or undressed material, are invariably termed "*tatua*." Those formed of many plaited strands are known as "*tu*." These *tu*, as known by the present-day Maori, are belts worn by women, whereas men wore the *tatua pupara*, which comes under the heading of "*tatua whara*."

In former times, however, the name "*tu*" was applied to a belt, girdle, or *māro* worn by warriors in battle, and also by priests. It is not clear as to whether this *tu* was simply a waist-belt or an apron such as the *maro*. Possibly the term was applied to a combination of the two, inasmuch as the term "*tu - maro*" is used in connection with certain ceremonies. (*Ka mau te tohunga ki tana tu-maro, ka karakia i te karakia makutu mo te hoariri. Katahi ka karakia i te Maro me te Wetewete.*)

Tu karetu: This was a woman's belt, or waist-girdle. It was formed of ten or twelve plaited strands (*kawai* or *kawekawe*) of the leaves of the *karetu*, a sweet-scented grass. The midrib (*tuaka*) is taken out from each leaf, or the leaves would be too brittle, and break when dry. The plait is usually of the *rauru* pattern. These plaited strands are only connected at the ends, where they are fastened together by the *tau*, or cord used for tying the *tu* round the waist. This cord is of plaited dressed flax-fibre, usually dyed black and red.

Tu-muka: This *tu* is made of dressed flax-fibre. It is composed of twelve strands, four being white, four black, and four red, the whole forming quite a showy girdle. The ends are plaited together to form the *tau*, or tying-ends. The strands have a singular appearance. Each strand is composed of two twisted threads (*miro*), which are twisted together by the rolling process before described, thus forming a *karure*. The operator then holds tightly the end of one of these threads, and pushes the other back (*he mea koneke*) until, instead of enveloping the held strand in a long spiral, it appears to be "seized" round it at right angles. (*Ko te kawai, he mea parahuhu. Ka miro, a ka parahuhu.*)

Tu-maurea: This *tu* is made from the bright reddish-yellow leaves of the *maurea*, but had a proportion of flax-fibre mixed with the *maurea* in order to strengthen it. This and the sweet-scented *tu karetu* were favourite material for belts with women. The *maurea* is not found in Tuhoe Land, but was obtained from the southern end of the Kainga-roa, near Taupo. The *karetu* has been destroyed by stock about Ruatahuna, but may be found in the secluded gulches around Lake Waikare-moana, and the wilds of the Parahaki, on the Upper Waiau. A famous saying is, "*He maurea kia whiria.*" Should a war-party be out on the trail, and encounter a stray person, or come to a village on the line of march, and propose to slay such person or persons, the latter will say, "*Kaua e kohiti te patu. He maurea kia whiria*"—that is, "Don't slay us, the common weeds, but go on and secure the *maurea*."

We observe a reference to the prized *maurea* in a lament composed by one Tama-ruru for a dead child:—

> Taku piki kotuku-e. Taku mapihi maurea-e
> Tena ka mamate ra ki tua o nga roto-e
> Ki taku kai kapua nana i ahuru-e
> Nana ra i tekateka kia tu ki te riri-na
> Taitaia ra e te hune o te toroa
> Kia pai ai koe ra te takoto i te kino-na.

Another *tu* was known as *tu-wharariki*, which is said to have been made pleasant to the young ladies of old by having the sweet-scented *kopuru* moss inserted therein. *Tu* were

also made of the culms of the *hangaroa*. In ancient days women often had a *tu* tattooed round their waists.

Tatua: As observed, *tatua-whara* is a generic term for all belts made of *harakeke*, or undressed flax.

Tatua-pupara: This is a man's belt. It is woven about 5 in. or 6 in. wide, of strips of flax about ⅛ in. in width, some of which are dyed black. The belt is woven in patterns, usually of a vandyke form. When woven the band is folded or doubled, thus forming a belt of some 2½ in. or 3 in. in width, the edges being turned in and stitched together with a cord of dressed flax. The *tau*, or tying-strings, are then fastened on at each end. This belt was sometimes used to carry small articles in, as Taukata of old carried the famous *kao kumara*.

Women's belts of undressed flax were woven about 4 in. wide, of black and white strips of flax, in various patterns, the zigzag pattern known as "*whakakokikoki*" being a favourite one. Two plaited cords (*kaha*) of dressed fibre dyed black are fastened along the inside of the belt, and at each end thereof are plaited to form the tying-cords in the *poutama* pattern. Such a belt is termed a "*poutama*," from this style of plait.

The belts of dressed flax-fibre, generally black, often worn by women now, are said to be a modern style, copied from the make of the green-hide saddle-girth. The following are names of patterns used in the making of belts, baskets, and sleeping-mats: *Poutama, whakapatiki, tokarakara, whakakaokao, panatahi, whakarau-nikau, whakatutu, tapuwae-kotuku, papaki-ngaro, torua.*

Baskets were made of many different shapes, and used for many purposes, in former times. Many are quite handsome, being worked in patterns of different colours—that is, in white, black, and red. A fine bright-coloured red strip for plaiting into baskets is obtained from the midrib (*tuaka*) of the *toi* palm. Baskets were made of undressed flax, also of undressed strips of leaves of the *ti* or cabbage-tree.

Kete-kai, or food-baskets: These were roughly woven of broad strips of green flax, and were for temporary use only. They supplied the place of plates and dishes, and were known by many names, such as "*paro*," "*tonae*," "*taparua*," &c.

Putea: This was a generic term for a finer class of baskets, used for holding small articles, such as ornaments, dressed fibre for weaving, &c. There are several different kinds of *putea*. Some have a flap to them, which covers the mouth of the basket, and is secured with a string. These are termed "*kopa*," and generally have a cord attached for the purpose of carrying them slung over the shoulders. They are made of narrow strips of flax, undressed but dried, some

of which are dyed black. They are woven in patterns with these black and white strips, and have a very neat appearance.

The *pu-kirikiri* was a basket used for holding seed *kumara* when that valuable tuber was being planted. The *pu-tutu* was used for straining the fruit of the *tutu*, the basket being lined with the feathery heads of the *toetoe*, or pampas grass, which retained the *huirua*, or poisonous property of the berries. The *ngehingehi* was a long *kete* used for squeezing the crushed berries of the *titoki*, for the purpose of expressing the oil. The *toiki*, or *tukohu*, was a long *kete* of a round shape, used to contain food when steeping in water. In former times large *toiki* were made of *pirita*, or supplejack, to store seed *kumara* in when placed in the *whata*, or storehouse.

Flax.

We here give a list of varieties of this valuable fibre-bearing plant, which list, however, is by no means complete, this not being a flax-producing district:—

Oue: This produces the best fibre.

Pari-taniwha: Gives a good fibre, which, however, requires to be steeped in water so soon as it is stripped, otherwise it assumes a reddish colour. After being steeped for some time it is taken out and hung up to bleach.

Wharariki: Sleeping-mats are made of this.

Rātāroa: A medium fibre.

Ngutu-nui: Used (undressed) for making nets and bird-snares.

Huhi: Has a very inferior fibre.

Tutae-manu: A very poor fibre.

Taneāwai: The variegated flax.

Ruatapu: He harakeke tapu. A sacred flax. Used for tying the hair in former times.

Dyes and Dyeing.

Two very good and fast dyes were used by the weaving fraternity of the *whare pora*. They were red and black. The black is used for both dressed and undressed flax, and its use is still common. The red dye is now but little used, for two reasons: First, the practice of *taniko* is almost obsolete; and, secondly, because the natives are beginning to use European dyes, which, I take it, is the death-knell of the ancient *whare pora*.

Black Dye: For this purpose there are two processes through which the fibre has to pass. It is first soaked in

water in which certain barks have been steeped, and afterwards it is placed in a certain black mud. For this black dye the bark of either the *hinau*, *tawai*, *tawhero*, or *hinau-puka* is used. This bark is placed upon a stone and beaten with a wooden mallet of *maire* wood, shaped like a thick pestle, until the bark is all bruised and broken up. The *patu* for beating fibres are made of black volcanic stone (*karā* and *uri*), which have a rough, open grain, the same being considered preferable for pounding fibre for *io* threads. These beaters are very neatly made, and were highly prized; being handed down for many generations. The one here obtained for the Auckland Museum is five generations old. When thoroughly crushed a portion of the bark is put into a wooden trough or bowl, or a trough hollowed out of a log. A layer of crushed bark is placed in the bottom of the trough. On this is placed a layer of fibre, then another layer of bark, and so on. The trough is then filled with water, and the fibre left to steep in the dye thus formed for twelve or sixteen hours. When taken out the fibre is sticky to the feel and by no means black, but of a dirty-brown colour. The fibre is then steeped for twenty-four hours in a peculiar black mud, such as is found in a white-pine swamp, and in which is seen a reddish exudation. (*Kia noho tetahi mea whero, waikura whenua, kai roto i te repo. Hai te wao kahikatea te paru pena. Ko aua tu paru he mea heri ki etahi kainga, ka whakato ki tetahi repo, a ka nui haere.*) Such swamps are famous places, and have been used for centuries, such as the one at Rakau-whakawhitiwhiti, near Te Umu-roa, while at Kaka-nui is a small swamp to which the desired mud has been "transplanted" from the former. This mud renders the fibre a deep black; in fact, it *is* the black dye, while the dark sap of the bark sets the dye of the mud. (*Ko te hinau hai pupuri i te pango o te paru.*) When dried the fibre is ready for the weaver.

Red Dye: This was obtained from the bark of the *toatoa* (or *tanekaha*). The bark is pounded and broken up. A separate fire is then kindled away from the settlement. It must not be a fire at which food it cooked, nor may it be kindled from such a fire. Thus there is a certain amount of *tapu* about this fire, and the process of dyeing fibre thereat must not be witnessed by others save the manipulators, otherwise the latter would lose their knowledge (*ka riro te matauranga*), which, however, may mean that onlookers would thus acquire the knowledge of dyeing, a circumstance by no means desired by the conservative members of the *whare pora*.

The crushed bark is placed in a vessel, which is then filled with water and placed on the fire, where it is allowed to boil for some time. In ancient times the bark was placed in an *oko*

and stone-boiled,* but now iron pots are used. After being allowed to boil for some time, the fibre to be dyed is placed in the vessel, the water in which is now coloured with the red sap of the *toatoa* bark. After being boiled for some time, a bed of hot, white, clean ashes is prepared, the fibre taken out and placed in these hot ashes, which is raked over the fibre. A stick is used as a poker, to separate the fibre, and keep turning and raking it, so that every part may come into contact with the hot ashes, and yet not be singed, burnt, or discoloured by the heat thereof. This process is *hai pupuri i te whero, koi mawhe* (to set the dye and prevent it from fading). The fibre is then again boiled in the dye for about ten minutes, after which it is hung up to dry, and is then ready for use.

In a district such as Rua-tahuna, where the *toatoa*-trees are few, they were much prized, and had special names. This tree is found on the Huiarau and Putai-hinu Ranges, but is scarce in the lower country.

Te Kiri-o-te-Rangi-tu-ke is a lone *toatoa*-tree, situated on the Tahua-roa Range. It is named from an ancestor of the Ngatitawhaki *hapu*, and from it is obtained the bark used in my own *whare pora*.

Te Kiri-o-Koro-kai-whenua is another such tree at Te Wera-iti. Only the descendants of those two ancestors may take bark from those trees.

Needles.

In former times feather-quills (*tuaka*) were used as needles, the base of the quill being used as the point and the thread of flax-fibre fastened to the end of the feather. It was used for mending cloaks, &c. The name of this quill-needle was "*toromoka*," which word also means "to sew with the same." (*Toromokatia toku na.*)

Plaiting.

Many different plaits are known to the Maori, each of which has its special uses. Among others are the following:—

Topiki.

Whiri-papa: A flat plait.

Whiri-kawe: A flat plait of three strands (*kawai*).

Whiri-tuapuku: A round (*topuku*) plait of four strands.

Rauru: A flat plait of five strands.

Iwi-tuna: A round plait of four strands.

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* *i.e.*, boiled by means of hot stones being placed therein, a common practice in ancient Maoriland.

Whiri-pekapeka: A flat plait of nine strands.

Whiri taura kaka: A square plait of ten strands. This pattern is said to have been copied from the peculiar square stem of the plant known as "*Te Whiri-a-Raukatauri.*"

Aute.

In an account of certain wars of the Ngatiawa Tribe, which occurred some six generations back, and which was given to me by H. Tikitu, of that tribe, I find the following: "Te Whata-manu and Te Manawa were kept by Te Rangi-ka-wehea as beaters of *aute*, for that was the clothing of old, and those two were clever at that work." This is the only note I have obtained from natives as to their knowledge of this ancient clothing, nor do I think that it obtained to any extent at that period.

Sandals, &c.

Several different kinds of sandals and gaiters were used in former days by the mountaineers of Tuhoe Land, principally in traversing the snow-clad ranges in winter. My notes on this head are meagre, and soon disposed of:—

Parengarenga: These are said to have been leggings of flax, woven into a broad piece, and then laced on to the leg extending from the ankle to just below the knee. In modern times sandals of pigskin were worn with these.

Tumatakuru: These were a species of sandal and galligaskin combined. They were made by a netting process, from the plant *tumatakuru* (*Aciphylla squarrosa*). *A. colensoi* is the *taramea*, an alpine spear-grass. The late Mr. T. Kirk gave me the native name of the former as "*kurikuri.*" The *tumatakuru* were a kind of sandal and half-legging combined. They were folded over the foot and above the ankle and laced on, being stuffed or lined with *rimurimu* (moss).

Rohe: This was a sandal and legging combined.

Kopa: This appears to have been another name for the folding sandal, as the word implies.

Papari: A combined sandal and legging made of green flax, and stuffed or lined with moss. They are said to have been a great boon to travellers in the snowy ranges.

Paenaena: This was a sort of toe-cap, netted of *muka* (= *whitau*), or dressed flax-fibre. They were used as a protection to the toes in walking, and were fastened with a cord passed round the ankle.

Tauri-komore: It is difficult to procure precise information as to this article. The name "*tauri*" or "*tauri-komore*" is applied to an anklet or bracelet. Some are narrow bands

woven of dressed flax-fibre and ornamented with *taniko;* such anklets were worn by women of rank. Others were made of the hollow culms of a plant called "*hangaroa*," through which threads of flax-fibre were passed, a band being formed of these. Te Kowhai, of Ngatiruapani, states, "The *tauri-komore* was an anklet. It was a *tohu rangatira*—a sign of good birth. They were made by stringing the *komore* (?) upon cords of plaited flax-fibre. The *komore* were hollow white objects brought from afar—I think, from the ocean. Many such cords were thus made and worn on the leg as an ornament." H. T. Pio says, "*Te tauri-komore kei raro tena i nga waewae o nga rangatira e here ana.*" The name was also applied to bands tattooed on the wrists or ankles. (*Komore* = a sea-shell.)

Pohoi: These were ear-ornaments of bird-skins. Such skins, *minus* head and wing- and tail-feathers, had a piece of round wood placed in them (*hai whakatopuku*), so that they would dry in that shape—*i.e.*, in a cylindrical form. They were worn suspended from the ears.

Poro-toroa: These were short pieces of the bones of the albatros, cut into lengths of about 2 in. They had a cord passed through them, and were suspended from the neck, the bone resting on the wearer's breast. I have seen but one native so adorned here, though the various greenstone pendants, *kuru, whakakai, kapeu* (or *tangiwai*), are numerous.

Heru, Combs: It is stated that these were formerly made of the stalks of the *heruheru* fern (*Todea intermedia*), also of bone and wood. The fine-toothed combs are made of *mapara,* the hard resinous heart-wood of the *kahikatea.* One such in my possession is ingeniously and neatly laced in the pattern known as *tapuwae-kautuku.*

Chaplets, &c.: These were made from the sweet-scented leaves of various shrubs and plants, such as the *tanguru-rake, koareare, kotara,* and *pua-kaito,* and were worn by women. Also head ornaments of feathers and various prized plumes were worn. The generic terms for the above ornaments appear to have been "*pare*" and "*rakai.*" *Rakai,* or *whaka-rakai,* also means to adorn the head with such gear. *Hakari* also means to adorn, as with clothing. Pigeon-oil and the oil expressed from the *titoki*-berries were scented with a moss called "*kopuru,*" or the gum of the *tarata*-tree, which tree is chipped at certain times to cause this gum to flow. Bird-skins, such as that of the *pukeko,* were prepared as for *pohoi,* and, having been scented with this oil, were worn suspended from the neck. This is termed a "*pona tarata.*" The *hei raukawa* was composed of strips of albatros-skin, with feathers attached, about 2 in. wide. Such strips were fastened to the odorous leaves of the *raukawa* shrub, and worn as

above. The *kopuru* and *tarata* gum were used in a like manner. Such were the ornaments of *Rua-tahuna paku kore* and *Rua-tahuna kakahu mauku.*

Potae taua : These were mourning-caps, or, more properly speaking, fillets, inasmuch as they possessed no crown. They were worn by widows in former times. They were made of a kind of large rush found growing on the margin of lakes, and known as "*kutakuta,*" or "*paopao,*" or "*kuwawa*"* (*ko te paopao, mehemea ka parahuhutia ka pakepake nga mea o roto*). The stalks were peeled of the outer covering, leaving the white inner part, which was then formed into a fillet for the head. In some cases the material was died black and a reddish-yellow (*manaeka*), the last colour being obtained by the same process as that described in making the *manaeka.* These coloured materials were then woven into a fillet, the *hukahuka* of which hung down all round the head, and covering the eyes of the wearer. The *potae taua* was secured by being tied at the back of the head. Other such mourning-caps were made of bird's tails (*kotore* or *humaeko*) fastened entire to the fillet, and which waved to and fro as the wearer moved.

Floor-mats, Sleeping-mats (Whariki and Takapau).

Whariki is a generic term for mats or covering for the floor, whether woven mats, coarse or fine, or merely leaves or *Lycopodium,* as is sometimes used. *Takapau* is applied to the finer class of sleeping-mats. Coarse mats, such as that termed "*tuwhara,*" are placed on the ground, and the fine-woven *takapau* of flax or *kiekie* over these. The leaves of the *kiekie* are split into narrow strips, which are bleached until quite white, the mat having a very neat and clean appearance. When split these strips are hung in the sun until half-dry, when they are taken down and beaten on the ground, the operator taking a handful (*tata*) and threshing them on the ground. They are then hung up again for a while. This process is repeated several times, until the strips are quite white. No dye or pattern-weaving obtains in connection with the *kiekie* mats.

Coarse floor-mats were also made of the *kutakuta,* described above. Mats of these kinds are made in several widths or pieces (*papa*), the leaves of the flax, &c., not being long enough to run right through. When a midrib (*tuaka*) is thus formed in weaving mats it is termed a *hiki,* which is the joining of two *papa.* (*Ka patai tetahi wahine,* "*E hia nga hiki o to whariki e toe ana?*" *Ka ki mai tera,* "*E toru.*" *Na, kua mohio e wha nga papa.*) The turning of the ends of the strips at the ends of a mat is termed "*tapiki.*"

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* See "maro-kuta."

We will now conclude by giving some of the rules pertaining to the art of the *whare pora*, and explain the various *aitua* (evil omens) that were liable to overtake those who did not strictly adhere to such rules.

The finer class of garments (*kakahu*) and the ornamental *taniko* thereof may be woven during the day-time only. So soon as the sun sets the weaver must release the right-hand *turuturu* and roll up or cover her work until the next day. Common garments (*puweru*) may be woven at night, but not the high-class articles. A weaver may, however, work at preparing the *io*, *aho*, or *hukahuka* at night. Should the above rule be broken the weaver will lose all knowledge of her art; the shades of night will deprive her of such. Should she weave such a garment at night, the same is a *tatai mate*, an evil omen, and a *tūpō*.

Aroakapa: When asleep, should a weaver, or her husband, dream that she sees a garment suspended before her (as on *turuturu*), it is the sleeper's spirit (*wairua*) that discloses such to her, as a token of misfortune to come. It is the impending misfortune that sends notice of its coming. This is known as an *aroakapa*. It is useless trying to escape from this *aitua*.

When engaged in weaving, should a stranger approach the weaving-house the weavers will cry him welcome, but at the same time each grasps the right-hand *turuturu* (the sacred one), and lays it down, or leaves it at an angle across her work. If left standing it would mean an *aroakapa*, and an evil omen for the offending weaver or her friends. If the guest is from afar the omen assumes an appalling magnitude. In this latter case the garment is taken off the *turuturu* and put aside, carefully covered, otherwise the *aroakapa* will be on hand. If it is a large party that arrives, and they enter the house where weaving is going on, the work is rolled up and placed aside. If only one or two people known to the weavers, then the women will remain seated by their work, and join in the conversation. But the sacred *turuturu* are still lying on the ground, and no weaving is done. If a stranger approaches such a house, and sees the *turuturu* are standing, he at once leaves or proceeds on his way. He knows that he has come unawares upon the weavers, and has brought disaster upon them. It is therefore a good place to migrate from.

When I paid a visit to Te Wai-o-hine, a famous weaver of Rua-tahuna who has made many old-time articles for me, as I entered the *whare* where she was weaving a *korowai* she seized the sacred *turuturu* and leaned it against the wall at an angle of 45°, thus slacking the *tawhiu*, but not covering or removing the garment, as she would have done had I been a

stranger. She, of course, ceased working until I had seated myself, when she re-erected her *turuturu*, and went on with her work.

Women will not smoke while weaving, and should they eat in the same house where the weaving is being done they will cover their work and go aside to eat.

Hukiora: If a chief from a neighbouring village arrive at the weaving-house, and should the weaver lean the *turuturu* over without detaching the work therefrom, that is a *hukiora*—she has saved herself from the evil omen. As the chief seats himself he will say, "Erect your *turuturu*."

Tahakura: It is an evil omen for the weaver to leave an *aho* uncompleted at sundown, when she leaves off work—that is, the *aho* is not carried out to the margin of garment at the right-hand *turuturu*. This is termed a *tahakura*. ("*Kua tahakura to whatu.*") That garment will never be finished by the weaver, for every succeeding *aho* (woof-thread) will prove to be short, and thus will not run out to the margin. The weaver will never again be able to concentrate her mind on the work to complete the same. The *tahakura* has unnerved her, and destroyed her power of continuity. That garment will have to be thrown away. As that worthy old adept, Te Whatu, of Rua-tahuna, remarked to me, "Such is the result of not having gone through the ceremony of *Moremore puwha;* one is afflicted by the *tahakura* and the *aroakapa.*" Moral: Let not the sun descend upon an incomplete *aho*, and enter thyself betimes as a novice for the all-powerful *Moremore puwha.*

But should a close acquaintance—*i.e.*, a man—chance upon a woman weaving, such is not an evil omen for her, albeit he will not remain. (*Ka ahua konekone, ara ka whakama, he kore hoa tane mona hai hoa noho.*)

Some authorities state that if an *aho* turns out to be too short the result is a *pouaru*—that is, either the weaver or her husband will shortly die. Should a person go behind a garment that is being woven—that is, on the opposite side to the weaver—and look at that garment, that also is an *aroakapa.*

In preparing *miro* (twisted threads) for the *io* and *aho* (warp and woof) of fine garments it is an *aitua* (evil omen) to throw the *hungahunga* or tow into the fire. All the knowledge of the weaver will be lost; it will be destroyed by the fire.

Weaving of fine garments must invariably be carried on under cover, never in the open, although it is quite sufficient if the weaver has merely a rough shelter of branches over her

work. Should this rule be transgressed the evils of the *tahakura* will descend upon the unhappy weaver.

When weaving, should the *aho* become knotted, it is a sign that visitors are coming; they will arrive to-morrow.

Should a *turuturu* fall without being touched—*na te rae tangata i turaki*—the brow of approaching man has overthrown it—that is, visitors are coming.

Contrast of colours: The Maori seems to have a good idea of contrasting colours in weaving. The term "*hae*," or "*wana*," seems to bear this meaning. When speaking of making a *tu muka*, Te Whatu said, "Let us have three colours, two are not enough; *kaore e hae* (they will not *hae*). (*Ara, kaore e wana te titiro atu i runga i te kakano kotahi, e rua ranei, tena ki te toru, ka nui te wana. Ko aua mea kai te ririri, e whakaputa ana i tona pai tetahi, e whakaputa ana i tona pai tetahi—koina te hae.*)"

Such are the meagre notes collected anent the ancient *whare pora* and the art of weaving as practised by the neolithic Maori of New Zealand. Meagre are they, and of a disconnected nature; yet is it well to preserve the little information on these matters that is accessible in these days of the *pakeha*. For the art of the *whare pora* is doomed, and the *aronui* and *maro-kopua* of old have been replaced by print dresses, the levelling prints of Manchester and the wooden-nutmeg State, which are procurable alike by slave and chieftainess. The rays of the setting sun are lingering on the dismantled and empty *whare pora*, the *tauira* come not, the *tohunga* has gone in search of the Living Waters of Tane, which he shall never find. The *Moremore puwha* is unknown to the present generation, the *tahakura* and *aroakapa* are objects of scorn. And even as I look from my tent-door out across the primitive vale of Rua-tahuna the declining sun drops behind the golden Peak of Maro, the purple shadows glide across the darkening forest, and the art of the *whare pora* is lost.

ART. LXVI.—*A Comparison of New Zealand Mortality during the Periods 1874–81 and 1881–91.*

By C. E. ADAMS, B.Sc., A.I.A., Engineering Scholar and Engineering Exhibitioner, Canterbury College, and Senior Scholar, New Zealand University; formerly Lecturer on Applied Mathematics, Canterbury Agricultural College.

[*Read before the Hawke's Bay Philosophical Institute, 11th October, 1897.*]

Plate LIX.

THE first systematic investigation into New Zealand mortality, involving the results of more than one census, was made by F. W. Frankland, F.I.A., in 1883. The results of his investigation, which are deduced from the three censuses of 1874, 1878, and 1881, are given in vol. xv. of the "Transactions of the New Zealand Institute," p. 500. The work was undertaken to furnish Alfred K. Newman, M.B., M.R.C.P., with statistics for his inquiry, "Is New Zealand a Healthy Country?"

The next investigation was for the period 1881–91, and was based on the three censuses of 1881, 1886, and 1891. The mortality during this period has been investigated by two independent observers—G. Leslie, Assistant Actuary, New Zealand Government Life Insurance Department, and the present writer. The paper of the former was published in the *New Zealand Journal of Insurance, Mining, and Finance* in September, 1895, while that of the latter appeared in the "Transactions of the New Zealand Institute," vol. xxix. It is worthy of note that although widely different methods were adopted the results agree in a remarkable manner. This is the more satisfactory as the results are so favourable to the colony that had they been obtained by one investigator only they might have been open to criticism.

The comparison submitted herewith is limited to the death-rate per hundred living for each year of age up to five years, then in intervals of five years, as this is the form in which Frankland's results are given. This comparison brings out many interesting features in colonial mortality. Among them may be mentioned,—

1. The improvement in infantile mortality: Both in males and females, from ages 0 to 5, the mortality has steadily decreased, the improvement being most marked in the females. This is shown in Plate LIX., where the dotted line representing the mortality from 1874–81 is higher than the continuous line representing the mortality from 1881–91.

2. This improvement continues during both the age-groups 5–10 and 10–15 in both males and females.

3. In the two following age-groups (15–20 and 20–25) the conditions are reversed, and the later period (1881–91) is worse than the former (1874–81), both for males and females.

4. From 25–30 the mortality has decreased.

5. It is now necessary to deal with the males and females separately, as up to this age-group (25–30) the changes in mortality have been similar in the two sexes; but from this group onwards the agreement is not so close. From 30–35 the mortality of males has increased.

6. For the following age-groups (35–40 to 55–60) the mortality has decreased.

7. From 60–65 to 75–80 the mortality has increased.

8. In females the mortality has decreased from 25–30 right up to 55–60.

9. From this group (55–60) to 70–75 it has increased.

10. From 75–80 it has decreased.

To sum up, the mortality in both sexes has decreased for ages from 0 to 15, and increased for ages 15–25. In males it has decreased for ages 25–30 and 35–60, and increased for ages 60–80; in females it has decreased for ages 25–55, increased for ages 55–75, and decreased for ages 75–80.

DEATH-RATE PER HUNDRED LIVING.

Ages.	Males.		Females.	
	1874–81.	1881–91.	1874–81.	1881–91.
Under 1 year ..	10 779	10·212	9·096	8·594
1–2 years ..	2·781	2·106	2·729	1·898
2–3 " ..	0 881	0·751	0·876	0·703
3–4 " ..	0·665	0·537	0 715	0·498
4–5 " ..	0·552	0·459	0·509	0·399
5–10 " ..	0·411	0·340	0·367	0·286
10–15 " ..	0·261	0·222	0·254	0·217
15–20 " ..	0·363	0·373	0 348	0·365
20–25 " ..	0·496	0·535	0·475	0·484
25–30 " ..	0·569	0·536	0·640	0·575
30–35 " ..	0·600	0·680	0·715	0·675
35–40 " ..	0 871	0·736	0 878	0·811
40–45 " ..	1·059	0·922	0 844	0·827
45–50 " ..	1·487	1·220	1·092	0·916
50–55 " ..	1·649	1·540	1·368	1·225
55–60 " ..	2·444	2·205	1·598	1·653
60–65 " ..	2·833	3·045	2·031	2·279
65–70 " ..	4·180	4·978	3 643	3·675
70–75 " ..	5·736	6·180	5·166	5·340
75–80 " ..	8·557	9·581	9·607	8·437

ART. LXVII.—*A Comparison of the General Mortality in New Zealand, in Victoria and New South Wales, and in England.*

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[*Read before the Hawke's Bay Philosophical Institute, 11th October, 1897.*]

Plates LX. and LXI.

IN a former paper on colonial mortality* the results relating to New Zealand were submitted. It is proposed to compare the general rates of mortality of this colony with those prevailing in New South Wales and Victoria and in England. It has often been stated that New Zealand is the healthiest place in the world: a cursory examination of the diagrams and tables herewith will fully bear out this statement. In every case New Zealand is in the lead. In Tables I. and II. are given the numbers surviving to each year of age out of ten thousand born alive. In New Zealand 9,033 males survive the first year, in New South Wales and Victoria only 8,672 survive, and in England only 8,414 survive. For females the results are better in each case, still, however, leaving New Zealand in the front; they are—in New Zealand, 9,183; in New South Wales and Victoria, 8,832; and in England, 8,713 survive the first year out of ten thousand born alive. Starting so well, it is but natural that this colony should maintain its position throughout the other years of life, which it does, for at age 75 the survivors are 2,663, 1,828, and 1,450 males respectively, and 3,349, 2,437, and 1,906 females respectively. Tables I. and II. are shown graphically in Plate LX.

It may be argued that because this colony starts so well with infant mortality the advantage may mask a possible

* "An Investigation into the Rates of Mortality in New Zealand during the Period 1881–91" (Trans. N.Z. Inst., vol. xxix., p. 52).

deterioration at some subsequent year of life. For instance, taking the figures for males at 30 and 31 years—

Age.	New Zealand	New South Wales and Victoria.	England
30	7,897	7,221	6,300
31	7,851	7,165	6,241

—it does not follow immediately that the year of age 30–31 is most favourable in the first country. To ascertain which provides the best chance of life it is necessary to know the number surviving the year out of the same number at risk for the year in each case. Thus, if instead of 7,897, 7,221, and 6,300 at age 30 there are ten thousand at this age in each country, then 9,941, 9,922, and 9,906 would survive the year. Hence at this particular age New Zealand again ranks first. Tables III. and IV., shown graphically in Plate LXI., have been prepared to bring out the comparison at each age. For the ages 16 and 17 (Males—Table III.) New South Wales and Victoria are as healthy as New Zealand, but at no other age are those colonies so healthy; while at ages 12, 13, 14, and 16 (Females—Table IV.) New South Wales and Victoria reach New Zealand's high level; and at age 15 females in New South Wales and Victoria have a better chance of living a year than those in New Zealand. At only one age is the mortality in England so light as in any of the colonies under discussion—at age 67 (Males—Table III.), where the English mortality is lighter than New South Wales and Victoria, but not so light as New Zealand.

The figures for New Zealand are taken from the paper previously referred to. Those for New South Wales and Victoria were compiled by W. R. Dovey, F.F.A., whose paper, "The Rates of Mortality in New South Wales and Victoria," was published in the *Sydney Record*, June, 1893, and relates to the period 1881–91. Another investigation into the mortality of New South Wales and Victoria, by A. Duckworth, for the same period—1881–90—it was not possible to use, as the sexes are not separated. The English figures for l_x are from the last English life-table, No. IV. (J.I.A., vol. 29, p. 30), and are for the period 1871–80. The values of p_x were specially calculated, as they are not given in the English table.

TABLE I.

l_x *(Males).*

x	New Zealand.	New South Wales and Victoria.	England.	x	New Zealand.	New South Wales and Victoria.	England.
0	10,000	10,000	10,000	40	7,376	6,585	5,631
1	9,033	8,672	8,414	41	7,315	6,510	5,553
2	8,869	8,368	7,902	42	7,252	6,432	5,473
3	8,801	8,257	7,637	43	7,185	6,352	5,392
4	8,757	8,180	7,466	44	7,116	6,270	5,309
5	8,720	8,120	7,341	45	7,044	6,185	5,224
6	8,686	8,077	7,268	46	6,967	6,096	5,137
7	8,655	8,044	7,211	47	6,886	6,004	5,048
8	8,627	8,015	7,163	48	6,802	5,908	4,958
9	8,604	7,989	7,123	49	6,715	5,808	4,865
10	8,584	7,966	7,090	50	6,625	5,706	4,770
11	8,566	7,945	7,061	51	6,533	5,599	4,673
12	8,548	7,925	7,036	52	6,439	5,488	5,570
13	8,530	7,906	7,012	53	6,342	5,372	4,465
14	8,511	7,885	6,988	54	6,239	5,253	4,357
15	8,490	7,865	6,964	55	6,131	5,129	4,247
16	8,465	7,841	6,937	56	6,015	5,001	4,134
17	8,437	7,815	6,907	57	5,893	4,869	4,017
18	8,405	7,785	6,875	58	5,763	4,732	3,898
19	8,370	7,751	6,839	59	5,625	4,591	3,776
20	8,331	7,713	6,800	60	5,481	4,447	3,650
21	8,290	7,673	6,758	61	5,336	4,299	3,521
22	8,247	7,629	6,713	62	5,187	4,147	3,388
23	8,202	7,584	6,668	63	5,031	3,993	3,253
24	8,157	7,536	6,620	64	4,869	3,833	3,114
25	8,112	7,488	6,571	65	4,697	3,671	2,972
26	8,069	7,437	6,520	66	4,504	3,498	2,826
27	8,026	7,385	6,468	67	4,299	3,318	2,678
28	7,984	7,332	6,414	68	4,085	3,131	2,528
29	7,941	7,277	6,358	69	3,864	2,942	2,375
30	7,897	7,221	6,300	70	3,642	2,759	2,221
31	7,851	7,165	6,241	71	3,430	2,574	2,065
32	7,803	7,107	6,181	72	3,229	2,386	1,910
33	7,754	7,048	6,118	73	3,035	2,199	1,754
34	7,704	6,987	6,054	74	2,848	2,012	1,601
				75	2,663	1,828	1,450
35	7,652	6,926	5,989				
36	7,601	6,862	5,921				
37	7,547	6,797	5,852				
38	7,492	6,729	5,780				
39	7,435	6,658	5,707				

TABLE II.

l_x (Females).

x	New Zealand	New South Wales and Victoria.	England.	x	New Zealand	New South Wales and Victoria	England.
0	10,000	10,000	10,000	40	7,498	6,775	5,961
1	9,183	8,832	8,713	41	7,436	6,702	5,892
2	9,028	8,529	8,205	42	7,375	6,628	5,821
3	8,964	8,425	7,934	43	7,314	6,553	5,749
4	8,922	8,352	7,754	44	7,254	6,477	5,676
5	8,889	8,294	7,626	45	7,193	6,399	5,602
6	8,860	8,253	7,557	46	7,132	6,320	5,526
7	8,833	8,221	7,503	47	7,069	6,240	5,449
8	8,811	8,192	7,456	48	7,004	6,158	5,370
9	8,791	8,169	7,417	49	6,938	6,074	5,290
10	8,773	8,147	7,384	50	6,869	5,988	5,209
11	8,757	8,128	7,354	51	6,794	5,900	5,126
12	8,739	8,110	7,327	52	6,716	5,810	5,042
13	8,721	8,093	7,301	53	6,634	5,719	4,956
14	8,701	8,074	7,276	54	6,548	5,626	4,870
15	8,678	8,054	7,250	55	6,458	5,530	4,774
16	8,652	8,031	7,221	56	6,365	5,430	4,674
17	8,624	8,004	7,190	57	6,267	5,326	4,570
18	8,592	7,974	7,156	58	6,164	5,217	4,461
19	8,557	7,940	7,119	59	6,055	5,102	4,347
20	8,521	7,902	7,079	60	5,941	4,983	4,228
21	8,483	7,865	7,036	61	5,824	4,861	4,105
22	8,443	7,824	6,991	62	5,702	4,735	3,976
23	8,402	7,780	6,945	63	5,574	4,605	3,843
24	8,360	7,735	6,898	64	5,439	4,472	3,705
25	8,316	7,686	6,849	65	5,296	4,338	3,562
26	8,271	7,634	6,798	66	5,134	4,175	3,413
27	8,225	7,582	6,747	67	4,962	3,996	3,260
28	8,177	7,528	6,694	68	4,780	3,809	3,102
29	8,129	7,472	6,640	69	4,592	3,619	2,939
30	8,079	7,416	6,584	70	4,401	3,429	2,772
31	8,029	7,358	6,527	71	4,210	3,237	2,602
32	7,977	7,299	6,470	72	4,015	3,041	2,429
33	7,923	7,239	6,410	73	3,811	2,842	2,255
34	7,868	7,178	6,350	74	3,592	2,640	2,080
				75	3,349	2,437	1,906
35	7,810	7,116	6,288				
36	7,750	7,052	6,226				
37	7,688	6,985	6,161				
38	7,625	6,917	6,096				
39	7,562	6,847	6,029				

TABLE III.

p_x *(Males).*

x	New Zealand.	New South Wales and Victoria.	England.	x	New Zealand.	New South Wales and Victoria.	England.
0	0·9033	0·8672	0·8414	40	0·9917	0·9886	0·9861
1	0·9818	0·9649	0·9391	41	0·9913	0·9881	0 9857
2	0 9924	0·9868	0·9665	42	0·9909	0·9876	0·9851
3	0·9950	0·9907	0·9775	43	0·9904	0·9871	0·9846
4	0·9958	0·9927	0·9832	44	0·9899	0·9864	0·9840
5	0·9961	0·9948	0·9901	45	0·9891	0·9856	0·9834
6	0·9964	0·9959	0·9921	46	0·9885	0·9849	0·9827
7	0·9968	0·9964	0·9933	47	0·9878	0·9840	0·9820
8	0·9973	0·9968	0·9945	48	0·9872	0·9831	0·9813
9	0·9977	0·9972	0·9953	49	0·9866	0·9824	0·9805
10	0.9979	0·9974	0·9960	50	0·9862	0·9812	0·9796
11	0·9979	0·9975	0·9964	51	0·9856	0·9802	0·9781
12	0·9979	0·9975	0·9966	52	0·9848	0·9789	0·9770
13	0·9977	0·9975	0·9966	53	0·9839	0·9778	0·9759
14	0·9975	0·9974	0·9965	54	0·9826	0·9765	0·9746
15	0·9971	0·9970	0·9961	55	0·9812	0·9751	0·9733
16	0·9967	0·9967	0·9958	56	0·9797	0·9736	0·9719
17	0·9962	0·9962	0·9953	57	0·9780	0·9718	0·9704
18	0·9958	0·9957	0·9948	58	0·9761	0·9704	0·9686
19	0·9954	0·9952	0·9943	59	0·9743	0·9685	0·9667
20	0·9950	0·9947	0·9937	60	0·9736	0·9668	0·9646
21	0·9948	0·9943	0·9934	51	0·9720	0·9647	0·9624
22	0·9946	0·9940	0·9932	62	0·9700	0·9627	0·9600
23	0·9945	0·9938	0·9929	63	0·9677	0·9600	0·9573
24	0·9944	0·9935	0·9926	64	0·9649	0·9578	0 9544
25	0·9947	0·9932	0·9923	65	0·9589	0·9528	0·9511
26	0·9947	0·9930	0·9920	66	0·9545	0·9484	0·9476
27	0·9947	0·9928	0·9917	67	0·9501	0·9436	0·9437
28	0·9946	0·9925	0·9913	68	0·9459	0·9399	0·9396
29	0·9945	0·9924	0·9910	69	0·9426	0·9378	0·9350
30	0·9941	0·9922	0.9906	70	0·9418	0·9327	0·9301
31	0·9939	0·9919	0·9903	71	0·9414	0·9273	0·9246
32	0·9937	0·9917	0·9899	72	0·9401	0·9215	0·9187
33	0·9935	0·9914	0·9895	73	0·9382	0·9152	0·9124
34	0·9933	0·9912	0·9892	74	0·9353	0·9084	0·9056
35	0·9932	0·9908	0·9887				
36	0·9929	0·9905	0·9883				
37	0·9927	0·9900	0·9878				
38	0·9925	0·9895	0·9873				
39	0·9920	0·9891	0·9867				

TABLE IV.

p_x (*Females*).

x	New Zealand.	New South Wales and Victoria.	England.	x	New Zealand.	New South Wales and Victoria.	England.
0	0 9183	0·8832	0 8713	40	0·9917	0·9893	0·9884
1	0·9831	0·9658	0 9417	41	0·9918	0·9889	0·9880
2	0·9929	0·9877	0 9609	42	0·9918	0·9886	0 9877
3	0·9953	0·9913	0·9774	43	0·9917	0·9884	0·9873
4	0·9964	0·9930	0 9835	44	0·9916	0 9880	0·9869
5	0·9967	0·9951	0 9910	45	0 9915	0·9877	0·9865
6	0·9970	0·9961	0·9928	46	0·9912	0·9873	0·9861
7	0 9974	0·9966	0·9938	47	0 9909	0 9869	0·9856
8	0·9978	0·9971	0·9948	48	0·9905	0·9863	0 9851
9	0·9980	0 9974	0·9955	49	0·9900	0 9858	0·9846
10	0·9981	0·9977	0·9960	50	0·9892	0·9853	0·9841
11	0 9980	0·9978	0·9963	51	0 9885	0 9848	0·9836
12	0·9979	0·9979	0·9965	52	0·9878	0 9842	0·9831
13	0·9977	0·9977	0·9965	53	0·9870	0·9838	0·9825
14	0·9974	0·9974	0·9964	54	0 9863	0·9830	0·9804
15	0 9970	0·9971	0 9961	55	0·9856	0·9820	0·9791
16	0·9967	0·9967	0·9957	56	0·9846	0·9809	0·9776
17	0·9963	0·9962	0·9953	57	0·9835	0 9795	0 9761
18	0·9960	0·9958	0·9949	58	0 9824	0·9780	0·9745
19	0·9957	0 9953	0·9944	59	0·9811	0·9767	0·9727
20	0·9956	0·9952	0·9939	60	0·9803	0·9754	0·9708
21	0·9953	0·9948	0 9936	61	0·9790	0·9741	0·9687
22	0 9951	0·9945	0·9934	62	0·9776	0 9726	0·9665
23	0 9950	0·9941	0·9932	63	0·9758	0·9710	0·9641
24	0·9948	0·9937	0·9929	64	0·9738	0 9690	0·9613
25	0·9946	0 9933	0 9926	65	0·9694	0·9637	0·9583
26	0 9944	0 9931	0·9924	66	0·9664	0·9570	0·9551
27	0·9942	0·9929	0 9922	67	0 9633	0 9531	0·9515
28	0·9941	0 9926	0·9919	68	0·9607	0·9503	0 9476
29	0·9939	0·9925	0 9917	69	0·9585	0·9474	0·9433
30	0·9937	0·9922	0 9914	70	0·9566	0·9440	0·9386
31	0·9935	0·9920	0·9911	71	0 9537	0·9394	0·9336
32	0·9933	0 9918	0·9909	72	0·9492	0·9344	0 9283
33	0·9930	0·9915	0·9906	73	0 9424	0·9291	0·9224
34	0·9927	0·9913	0·9903	74	0·9323	0·9233	0·9162
35	0·9923	0·9910	0 9900				
36	0·9920	0·9905	0·9897				
37	0·9918	0·9903	0·9894				
38	0·9917	0·9899	0·9890				
39	0·9916	0·9896	0·9887				

Art. LXVIII.—*An Account of the Fiji Fire Ceremony.*

By Dr. T. M. Hocken, F.L.S.

[*Read before the Otago Institute, 10th May, 1898.*]

Amongst the many incidents witnessed during a recent visit to the tropical islands of Fiji probably none exceeded in wonder and interest that of which I propose to give some account this evening, and to which may be applied the designation of "fire ceremony." It is called by the natives "*vilavilairevo.*" In this remarkable ceremony a number of almost nude Fijians walk quickly and unharmed across and among white-hot stones, which form the pavement of a huge native oven—termed "*lovo*"—in which shortly afterwards are cooked the succulent sugary roots and pith of the *Cordyline terminalis*, one of the cabbage-trees, known to the Maoris as the "*ti*," and to the Fijians as the "*masawe.*" This wonderful power of fire-walking is now not only very rarely exercised, but, at least as regards Fiji, is confined to a small clan or family—the *Na Ivilankata*—resident on Bega (= Mbenga), an island of the group, lying somewhat south of Suva, and twenty miles from that capital.

A small remnant of the priestly order at Raiatea, one of the Society Islands, is yet able to utter the preparatory incantation, and afterwards to walk through the fire.

It exists also in other parts of the world, as in parts of India, the Straits Settlements, West India Islands, and elsewhere. Very interesting accounts of the ceremony as seen at Raiatea and at Mbenga are to be found in the second and third volumes of the "Journal of the Polynesian Society," and in Basil Thomson's charming "South Sea Yarns." These descriptions filled our small party of three—my wife, Dr. Colquhoun, and myself—with the desire to witness it for ourselves, and, if possible, to give some explanation of what was apparently an inexplicable mystery. Our desires were perfectly realised.

The Hon. Mr. A. M. Duncan, a member of the Legislative Council of Fiji, and agent at Suva of the Union Steamship Company, to whom I carried a letter of introduction from Mr. James Mills, the managing director of that company, was most courteous and obliging, and promised his best efforts in the matter. His energy and ready response succeeded, with the result that a large party from Suva enjoyed such a day as each one must have marked with a red letter.

It was necessary to give the natives three days in which to make their preparations—constructing the oven and paving it with stones, which then required heating for thirty-six or forty-eight hours at least with fierce fires fed with logs and branches. They had also to gather their stores of food to form the foundation of the huge feast whose preparation was to succeed the mystic ceremony. During these three days we lost no opportunity of collecting from former witnesses of the ceremony whatever information or explanation they could afford, but with no very satisfactory result: the facts were undisputed, but the explanations quite insufficient. Some thought that the chief actors rubbed their bodies with a secret preparation which rendered them fireproof; others that life-long friction on the hard hot rocks coral-reefs, and sands had so thickened and indurated the foot-sole that it could defy fire; but all agreed as to the *bona fides* of the exhibition. The incident recounted in the "Polynesian Journal" was also confirmed—where Lady Thurston threw her handkerchief upon the shoulder of one of the actors, and, though it remained there but a few seconds before being picked off by means of a long stick, it was greatly scorched.

The story or legend attached to this weird gift of fire-walking was told us, with some variation, by two or three different people, and it is mainly as follows: A far distant ancestor of the present inheritors of this power was walking one day when he espied an eel, which he caught, and was about to kill. The eel squeaked out, and said, "Oh! Tui Na Galita (=Eng-Galita), do not kill me; spare me. I am a god, and I will make you so strong in war that none shall withstand you." "Oh, but," replied Na Galita, "I am already stronger in war than any one else, and I fear no one." "Well, then," said the eel, "I will make your canoe the fastest to sail on these seas, and none shall come up with it." "But," replied Na Galita, "as it is none can pass my canoe." "Well, then," rejoined the eel, "I will make you a great favourite among women, so that all will fall in love with you." "Not so," said Na Galita, "I have one wife, of whom I am very fond, and I desire no other." The poor eel then made other offers, which were also rejected, and his chances of life were fading fast when he made a final effort. "Oh, Na Galita, if you will spare me I will so cause it that you and your descendants shall henceforth walk through the *masawe* oven unharmed." "Good," said Na Galita, "now I will let you go." This story varies somewhat from that told in the "Polynesian Journal."

The eventful morning was blazingly hot and brilliant, and the vivid-blue sky was without a cloud as we steamed down

towards Mbenga in the s.s. "Hauroto." Mr. Vaughan, an eminent inhabitant of Suva, who has charge of the Meteorological Department there, was of our party, and carried the thermometer. This was the most suitable for our purpose procurable; it was in a strong japanned-tin casing, and registered 400° Fahr. We had also three amateur photographers.

Owing to the numerous coral-reefs and shallows, we finally transhipped into the "Maori," a steamer of much less draught. Approaching the silent verdure-clad islet, with its narrow beach of white-coral sand, we saw a thin blue haze of smoke curling above the lofty cocoanut-trees at a little distance in the interior, which sufficiently localised the mysterious spot. We now took the ship's boat, and soon, stepping ashore, made our way through a narrow pathway in the dense bush until we came to an open space cleared from the forest, in the midst of which was the great *lovo*, or oven.

A remarkable and never-to-be-forgotten scene now presented itself. There were hundreds of Fijians, dressed according to the rules of nature and their own art—that is, they were lightly garlanded here and there with their fantastic *likulikus* of grass, ornamented with brilliant scarlet and yellow hibiscus-flowers and streamers of the delicate ribbonwood. These hung in airy profusion from their necks and around their waists, showing off to advantage their lovely brown glossy skins. In addition, many wore clean white-cotton *sulus*, or pendant loin-cloths. All were excited, moving hither and thither in wild confusion, and making the forest ring again with their noisy hilarity. Some climbed the lofty cocoa-palms, hand over hand, foot over foot, with all the dexterity of monkeys. The top reached, and shrouded amongst the feathery leaves, they poured down a shower of nuts for the refreshment of their guests.

The celerity with which they opened the nuts was something astonishing, and afforded an example, too, as to the mode of using stone implements. A stout, strong stick, 3 ft. long, and sharpened at both ends, was driven into the ground, and a few smart strokes upon it soon tore from the nut its outer thick covering. The upper part of the shell was then broken off by means of a long sharp-edged stone as cleanly and regularly as the lid of an egg is removed with a knife, and then was disclosed a pint of delicious milk, a most welcome beverage on that overpoweringly hot day.

The great oven lay before us, pouring forth its torrents of heat from huge embers which were still burning fiercely on the underlying stones. These were indeed melting moments for the spectators. The pitiless noontide sun, and the no less pitiless oven-heat, both pent up in the deep well-like forest

clearing, reduced us to a state of solution from which there was no escape. Despite this the photographers took up their stations, and others of us proceeded to make our observations. The *lovo*, or oven, was circular, with a diameter of 25 ft. or 30 ft.; its greatest depth was perhaps 8 ft., its general shape that of a saucer, with sloping sides and a flattish bottom, the latter being filled with the white-hot stones. Near the margin of the oven, and on its windward side, the thermometer marked 114°.

Suddenly, and as if Pandemonium had been let loose, the air was filled with savage yells; a throng of natives surrounded the oven, and in a most ingenious and effective way proceeded to drag out the smouldering unburnt logs and cast them some distance away. Large loops of incombustible lianas attached to long poles were dexterously thrown over the burning trunks, much after the manner of the head-hunters of New Guinea when securing their human prey. A twist or two round of the loop securely entangled the logs, which were then dragged out by the united efforts of scores of natives, who all the while were shouting out some wild rhythmical song. This accomplished, the stones at the bottom of the oven were disclosed, with here and there flame flickering and forking up through the interstices. The diameter of the area occupied by those stones was about 10 ft., but this was speedily increased to a spread of 15 ft. or more by a second ingenious method. The natives thrust their long poles, which were of the unconsumable wi-tree (*Spondias dulcis*), between the stones at intervals of perhaps 1 ft. A long rope-like liana—*wa*—previously placed underneath the poles, and 1 ft. or 2 ft. from their extremities, was now dragged by scores of lusty savages, with the effect of spreading and levelling the stones. This done, our thermometer was suspended by a simple device over the centre of the stones, and about 5 ft. or 6 ft. above them; but it had to be withdrawn almost immediately, as the solder began to melt and drop, and the instrument to be destroyed. It, however, registered 282° Fahr., and it is certain that had not this accident occurred the range of 400° would have been exceeded, and the thermometer burst.

During all these wild scenes we had seen nothing of the main actors—of the descendants of Na Galita. Doubtless to give more impressive effect they had been hiding in the forest depths until the signal should be given and their own supreme moment arrive. And now they came on, seven or eight in number, amidst the vociferous yells of those around. The margin reached, they steadily descended the oven-slope in single file, and walked, as I think, leisurely, but, as others of our party think, quickly, across and around the stones,

leaving the oven at the point of entrance. The leader, who was longest in the oven, was a second or two under half a minute therein. Almost immediately heaps of the soft and succulent leaves of the hibiscus, which had been gathered for the purpose, were thrown into the oven, which was thus immediately filled with clouds of hissing steam. Upon the leaves and within the steam the natives, who had returned, sat or stood pressing them down in preparation for cooking the various viands which were to afford them a sumptuous feast that evening or on the morrow.

But for us the most interesting part of the drama was over, and it only remained to review observations and draw conclusions. Just before the great event of the day I gained permission to examine one or two of the fire-walkers prior to their descent into the oven. This was granted without the least hesitation by the principal native Magistrate of the Rewa district, N'Dabea by name, but generally known as Jonathan. This native is of great intelligence and influence, is a member of the Na Galita Clan, and has himself at various times walked through the fire. On this occasion he took no other part in the ceremony than that of watching or superintending it. The two men thus sent forward for examination disclosed no peculiar feature whatever. As to dress, they were slightly garlanded round the neck and the waist; the pulse was unaffected, and the skin, legs, and feet were free from any apparent application. I assured myself of this by touch, smell, and taste, not hesitating to apply my tongue as a corroborative. The foot-soles were comparatively soft and flexible—by no means leathery and insensible. Thus the two Suvan theories were disposed of. This careful examination was repeated immediately after egress from the oven, and with the same result. To use the language of Scripture, "No smell of fire had passed upon them." No incantations or other religious ceremonial were observed. Though these were formerly practised, they have gradually fallen into disuse since the introduction of Christianity. I did not succeed in procuring the old incantation formula; doubtless it was similar to that of the old Raiatean ceremony, which is given in the second volume of the Polynesian Society's Journal, p. 106.

Whilst walking through the fire Dr. Colquhoun thought the countenances of the fire-walkers betrayed some anxiety. I saw none of this; nor was it apparent to me at either examination. The stones, which were basaltic, must have been white-hot, but due to the brilliance of the day this was not visible.

Various natives, being interrogated for an explanation, replied, with a shrug, "They can do this wonderful thing; we cannot. You have seen it; we have seen it." Whilst thus

unable to suggest any explanation or theory, I am absolutely certain as to the truth of the facts and the *bona fides* of the actors. A feature is that, wherever this power is found, it is possessed by but a limited few. I was assured too that any person holding the hand of one of the fire-walkers could himself pass through the oven unharmed. This the natives positively assert.

My friend Mr. Walter Carew, for thirty years a Resident Commissioner and Stipendiary Magistrate in Fiji, has frequently conversed with Jonathan (referred to above), who, whilst withholding no explanation, can give none. He says, "I can do it, but I do not know how it is done"; and, further, that at the time he does not experience any heat or other sensation.

Does any psychical condition explain these facts, as suggested in Lang's "Modern Mythology"? I certainly did not observe any appearance of trance or other mental condition. In connection with this Mr. Carew thinks that intense faith is the explanation, and that if this were upset the descendants of Na Galita would be no longer charmed. But it is difficult to see how any mental state can prevent the action of physical law. Hypnotism and anæsthetics may produce insensibility to pain, but do not interfere with the cautery.

Many of the so-called fire miracles are remarkable indeed, but are readily explained, and by no means come within the present category. Such, for instance, as plunging the hand, which is protected by the interposed film of perspiration assuming the globular state of water, into boiling lead. Similarly, many conjuring feats. At the beginning of this century an Italian—Lionetti—performed remarkable experiments—rubbed a bar of red-hot iron over his arms, legs, and hair, and held it between his teeth; he also drank boiling oil. Dr. Sementini, of Naples, carefully examined these experiments, and experimented himself until he surpassed the fire-proof qualities of his suggestor. He found that frequent friction with sulphurous acid rendered him insensible to red-hot iron; a solution of alum did the same. A layer of powdered sugar covered with soap made his tongue insensible to heat. In these and similar instances however, an explanation, though probably not a very sufficient one, has been given, but in that forming the subject of this paper no solution has been offered. Lang's chapter on the "Fire-walk" should be consulted; his account of the Bulgarian *Nistinares* is as wonderful and inexplicable as anything here recited. The whole subject requires thorough scientific examination.

ART. LXIX.—*Moa Farmers.*

By RICHARD HENRY, Resolution Island.

Communicated by Sir James Hector.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

IN one of the late Professor Parker's valuable papers he showed that some fifteen or sixteen reputed species of moas lived in New Zealand about the same time. "A most unexpected result," he says, "since all other great flightless birds inhabit each its own country or district. In the whole of Australia, for instance, there are only two species of emu and one of cassowary, while no fewer than seven species of moa have been found in one and the same swamp."

But here enters the old disagreement about what constitutes a species; and when the best authorities disagree laymen may fairly assume that the question is not, and probably never will be, settled while animals continue to vary. If every man varies, and every living thing is born somewhat different from all others, and if no two leaves in the forest are exactly alike, then why need we disagree about what appears to be only a matter of degree in a universal law? Nature does not build up an animal or a plant in a day, nor always in a century, even from legitimate progenitors; then why should an experimenter expect, in what is comparatively an atom of time, to mix two species that may have taken ages for divergence with millions of individuals and varieties of conditions? An able agricultural writer recently alluded to the "fixity of species" as Nature's majestic law, because some Yankee farmer in his hurry could not mix buffalo with common cattle; as if one man's lifetime was an appreciable period in the existence of such animals in America!

If Professor Owen had known as little about cattle as he did about moas he would certainly have classed those with horns and those without as different species, though that buffalo farmer would never think of doing so. And, under like conditions, the learned professor, with a cargo of bones, would have given us at least fifty different species of dogs, when with only a cartload of bones he made us out a dozen different species of moas. There were tall greyhound-like moas, and stout massive ones, and on down to little Dandy Dinmont things not above 2 ft. high. This great variety living together suggests the interference of men, for surely

without such there would not be so many different kinds of dogs and fowls as we have with us now.

We do not find many kinds of wild dogs in Australia, all being levelled up to nearly the one standard of size and colour, because they were practically without interference. On the other hand, there were as many different sizes of kangaroos as there were of moas, but directly under the influence of men and dogs as enemies, from which the moas must have been exempt for ages.

The necessities of defence and concealment in the kangaroo's case gave the various sizes great advantages in their own localities. The wallaby in the scrub, and the "old man" on the plain, had better chances there to escape and multiply, for the eagle-hawk would have seen the wallaby in the open, and the man or dog would have had a better chance to stalk or rush the "old man" in the bush. So that there was something to force their divergence and then keep them apart; while the moas either had men for masters or farmers or had their world to themselves, without an enemy that they cared for. They had an eagle, of course, but it probably had plenty to do attending to the flightless swans or geese, for it was hardly heavy enough to prey even upon moa chickens.

There were identical species of moas in both Islands, which is wonderful when we remember their aptitude for variation, and to my thinking almost proof that the old natives farmed them as we farm sheep, and transported them with the other ground birds from one Island to the other. Stores of food and fencing would have been required according to our ideas of keeping ponies and draughts from intermingling, but these are small matters arising wholly from our habit of thinking that all the old people were fools—an error that will account for many of our difficulties in understanding such things. If it is a fact that the Maoris came and went from New Zealand six hundred years ago through the trackless sea, they must have known more about navigation than Englishmen at that time, who were then afraid to go out of sight of land; while the Maoris may have been weeks at sea, steering their course by some subtle art and science that some of us at least cannot now understand. Then, why need we trouble our heads about the fencing and food required for a moa farm? The Lyttelton steamer the other day lost her way in going to the Chatham Islands, and had some trouble to find her destination.

I have read recently that the words for counting from one to ten in the Madagascan language and in Maori are nearly identical, and if that is a fact the dialect is likely to have come almost direct to New Zealand, or at least without any long delays among other island tongues. And, if it was not

for the habit of thinking above alluded to, we might easily believe that the Madagascan moa was brought here by old-time navigators, who could have also brought roots and fruit and corn for its food, for we are not sure that the climate has been the same since the moa's first arrival. The earth may have taken a slight list to the south since then, and an age of heat, unlike the cold, leaves no deep grooves behind, unless its marks may be in the recent cool and changing forest trees.

If we only knew of oxen by their bones and horns we should not judge them easily farmed; so there possibly need have been no difficulty in taming the moas. The question is, Did the men bring them here, or find them here when they came? In the latter case the herds would have been too tame for hunting, and it would have been only a matter of butchering them when required; and surely a people intelligent enough to build and provision a vessel to bring their families over the sea—no matter from where—would have had sense to see the value of the moas in time to save and foster them, especially in such places as the Canterbury Plains, where the various kinds could have been tended for ages as we tend our sheep.

That there were moa-hunters there need be no doubt, for the arrow-heads alone would almost prove that; but they were probably recent Maoris developed into hunters of peaceful men, and then following up their calling by hunting the moas off the earth. As for not finding human bones with moas, we know how few of ours will be found with those of our sheep, for instance, because the latter are everywhere, with millions of better chances of finding favourable conditions for preservation and ultimate discovery.

At Manapouri Homestead, twelve miles from the lake of that name, and perhaps 100 ft. above it, Mr. Mitchell used to find stone tools and fragments enough to show that the place had once been the site of an old village, and that was almost proof that the lake was up there then. The "Long Valley" would have been the harbour, and the peninsula on which the house is built would have sheltered the village from the north wind. I think the outlet from a deep lake would hardly wear at all when there are no stones to rattle down in floods; but in this case the Mararoa River brought down material from the drift hills to form Manapouri Plain, and then supplied the stones to cut down the outlet from the lake; while Te Anau, having no such officious river, has long remained about the same. The level of this old village would probably make them into one great lake, bounded on the south by the Takitimos, which I heard translated as "great margin," which would have been very appropriate then, but is meaningless

now. If the translation is correct, it is evidence that those old villagers lived on the bank of the great lake, and handed down the name from some far off time when totaras grew on the hills instead of tussock and birch.

On the Bullock Hills, a few miles away, I found what is known as a Maori oven, and near it, on the surface, a patch of moa gizzard-stones; and during my ten years at Te Anau I found—away from the lake—several such scraps of history which could not have been all coincidences.

On the south of Te Anau, a few feet above high water, patches of gizzard-stones are quite easy to find—after a fern fire—lying on the surface of alluvial soil quite apart from other stones, for, of course, such is the only place in which they could be identified in a stony country like that. They are of any size from that of peas up to small hen-eggs, probably representing different sizes or ages of birds, and they tell the story of how the birds died there, or the hunter emptied out the gizzards he wanted to carry away for food; and it is evident that they were never washed by waves or driven by streams or glaciers, or they would have been scattered. So Te Anau remains about the same level since the moa's time, while Manapouri has gone down 100 ft. at least, for I do not remember finding any moa traces on that lower plain.

There was an old village at Te Anau occupied perhaps as late as 1840, but also for a very long time previously, as shown by the distance of some of the sites away from the slowly receding lake and its driftwood. Yet within a stone's throw of the lake, between the little dunes, a party of us found a basketful of big charred knuckles and broken moa-bones, with the charcoal in the fireplace still on the surface, as if it had been used only a few years before. When I first went up there arrow-heads and pieces of moa-bone were common finds. Spear-heads most people call them; but no native would lash a rudely chipped stone on the end of a spear for penetration—the lashing alone would destroy it for that. He would sooner point the stick like the Australians; and every boy knows the necessity of a weight on the point of his arrow. The native evidently did lash those heads on something, and I cannot think of anything else but a big arrow for the sake of the weight to strike a powerful blow, which in my experience is most effective in stunning or stopping an animal.

Some one has written that those charred bones were used for "firewood," but that is so easily settled by experiment that it would not be worth mentioning but to show that some one is always willing to tangle the ends of every question. At Te Anau traces of trees are as old as the hills, and probably driftwood has always been abundant since then, so that there

was no sense in any one charring old bones up there; and a grass fire cannot, at all events, char the underside of a bone, for it will not always darken the bleaching on its top.

Some one may ask why those fanciful navigators did not take something more useful than the moa. Well, an animal's value in that light greatly depends, first, on its disposition, and then on its food and on its ability for doing mischief. If the moa was as good-natured and as omnivorous as the weka it would have been a great recommendation in the eyes of the old voyager, with his limited space and opportunity for obtaining food by the way. A weka will eat fish, flesh, or fowl, and get rolling fat on berries, though its staple food is insects. Our tame wekas catch and eat all the goldfinches that come to our place, and they are the greatest egg thieves I ever met, and will stay by a dead penguin or a big stranded fish while there is a mite on its bones, apparently eating nothing else for days, though they have a strong muscular gizzard with gravel in it like that of a goose.

The moas may have been far easier controlled and less mischievous than pigs; may have bred several times a year, like the roa, when food was abundant; may have grown faster than our sheep, and produced better meat, though the latter, of course, would greatly depend on the livers of those old people, who may have been wise enough to choose what would suit them best. They also took care to bring no beasts of prey or noxious things, which would hardly have happened if New Zealand was the remnant of a sunken continent. So I think we might assume that it was the men that stocked New Zealand, if they came here at all of their own accord; and it would be quite easy to believe this if we would only admit that some people this side of Suez could have built and steered a decked vessel about the same time as Noah.

ART. LXX.—*Old Huts at Dusky Sound.*

By R. HENRY, Resolution Island.

Communicated by Sir James Hector.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

JUST a gossip about some old huts here which I only found a few days ago. It may be well known that there was an old pa here, but I never heard of it.

The site of the villages was on the sunny side of Luncheon

Cove, on the slopes of a little valley, where every floor needed levelling out, so that they are now easily seen, though all else has nearly disappeared. The wreck people may have lived there, and the sealers evidently built a few huts, for the "pungas," or fern-tree stems, were cut with wide, sharp axes; but long before that every desirable site in the cove and on the neighbouring islands was occupied by little huts about 8 ft. long and 6 ft. wide, and in one spot I think there was a big place, but this and all the little floors are now thinly grown over with fern-trees from 6 ft. to 12 ft. high, and also a dense growth of young trees, so that I had anchored several times in the cove and did not know that there was subject for so much interest within a stone's throw.

The sealers' huts are now mounds of "pungas," very useful in showing stages in the decay of such material, which is wonderfully slow—so slow that some of these huts, which were a good size, may have been built by Mr. Reven's men, who came here in the "Britannia" in 1872, and started to build their little vessel there (perhaps), because it was the nearest cove to the seals.

All the good firewood has been long ago cut down, and only a few red-pines are left standing. On one of these the date 1882 was chopped with an axe, and still looks quite fresh; but on the other was a very old mark, the common sailor's signature of the last century—X. I suppose the poor fellow did his best, and that the date was too much for him—partly our loss.

I had no spade, and got no certain evidence of the presence of Maoris, but there is no doubt about the great age, for a rata-tree 1 ft. thick had grown on one of the floors, and was cut down by the early sealers. It is the only possible place for women and children to live in the sound, because there are few or no sandflies there, and it is sunny, perfectly sheltered—the most beautiful little harbour you could imagine, and mild because of the warm sea-current, which is often 55° on a frosty morning up at our place. So we may be sure the Maoris did live there for centuries, when the sea was swarming with seals, which had secret breeding-places then; and, when a boat's crew could get a hundred a day, the Maori could get plenty of the best of clothes, and, to his taste, delicious food also, abundance of fish in the smooth water, penguins in season and their eggs, and mutton-birds on some of the islands, so that we might expect the presence of a pa there. But why did not Cook see it? He was in there, and marked the cove nicely on his map (a copy of which Mrs. Hocken gave me), which none of the other map-makers have done or even made a decent attempt at. If, however, there was a fringe of trees round the water, and the natives, aware of his

presence, put out fires and laid low, he might have missed seeing the village, if he only put in to the first creek for lunch on his way out round the island.

I stayed several days, for the dim traces were of great interest. I could distinctly trace the pathways worn out of the hillside, and in one place a piece going up hill was corduroyed with the durable "pungas," just barely preserved well enough to give an idea of their origin. In another some rude fellow had built his hut in the natural path, and every one had to go up hill a little to get past it, for the place was crowded with huts, and on many are little mounds of decayed "pungas" grown over with scrub and fern-trees.

It is not only pleasant in the cove, but outside it is beautiful among the many little islands, where the water is so smooth. I landed on several islands, but it takes time, for there are about forty of them. They are all bush, of course, but it is not hard to walk through. They are generally pretty high, and some are little mountains too steep to climb. I think I saw traces of huts everywhere I landed, so that there must have been a great number of people here at one time. Then, by the greatest piece of good luck, I went to a steep little flat-topped island in the sun, on the side of a narrow strait, and there I found two little huts standing entire, just as they were left, perhaps, a hundred years ago, though this is hard to believe, one of them looked so good. The wind had eddied the dry leaves into it, which suggested a sleeper there not long ago, but it must have been a Van Winkle, for out of the roof is growing a tree, a *Senecio*, not up through the roof, but it started on top, and sent its roots down the punga roof. It is in an airy dry place, where you may suppose the tree that loves the wet would not grow quickly, yet its stem is 6 in. thick. I wish I could send the hut to you, but it is too frail to move, for my dog got up on it and broke in a rafter. It is about 8 ft. long and 6 ft. wide, ridge-pole and all of pungas, with one end open. It is a hovel that any man would need long training to live in, so it is probably that of a Maori who could not find room to suit him in the cove, or a temporary camp. I often wondered what they did for a tent, but there it is, and not a bad substitute when it is cold and windy; and the material was easily cut with their stone axes. Or perhaps it was a Maori of later date who wanted to hide, because it is in the most unlikely place for any one to land, and there is a good look-out. Fancy some refugee of that broken tribe, who had experience of the sealers' tender mercies, living here until recent years, distrusting everything in a boat, or in the shape of a man. Maybe he is not dead yet, and if ever I find him I will present him with a beautiful dinghy, axes, spike-nails, and fishhook, and then be as happy

as him. But I am afraid he is dead long ago for want of his sealskin clothes.

I was doubtful about these being Maori habitations when I could not find the stones for fireplaces in the centre of the floors, but they could not have had a fire in this hut. It must have been only a sleeping-place, and they may have had a big kitchen. The smallness of the huts suggests temporary camps, as if they only came here in the season for seals; but they could not flourish here without plenty of canoes, so that the large population had either grown up here or come by sea, and Cook's description of the canoe does not suggest a sea-going craft.

I shall take a spade when I go out there again, and will write to you if I have anything worth writing about.

I have been several times to Pickersgill Harbour, and Captain Cook's clearing is quite easily traced by the old stumps and fallen trees on the hill, where no one else had any business. Even some of his small cut totara firewood is there yet, but of course no one would believe that. However, I am sending you a piece of totara older than that in a case going to Mr. Maitland—part of a side board of a canoe which we found under a cliff 100 ft. above and a quarter of a mile from the sea. The board was about 6 ft. long.

Art. LXXI.—*Red Cats and Disease.*

By R. Henry, Resolution Island.

Communicated by Sir James Hector.

[*Read before the Wellington Philosophical Society, 14th March, 1899.*]

In 1881, at Manapouri Station, there were a good many wild cats out on the run; red ones were also common, but I heard that they were always males. I found several nests of tabby kittens during my two years there, but most of them were half-blind and sickly, so that I thought the disease would prevent them being of any great use among the rabbits. I also saw several half-grown dead ones that had apparently died of distemper. However, the reddish ones always looked big and healthy, but it took me ten years to realise that there might be some relationship between that colour and the liability to disease, which was very hard on dogs up there at that time.

I tried to rear some pups then, but they all died except two red ones that hardly got sick at all, and grew into fine

dogs. This might have given me the hint, but I did not see it until 1891, at Te Anau Downs Station, when there was a half-wild tabby cat that had a litter of kittens not far from the house. As the kittens grew up I noticed there was one red one, and that some of the others were sick. I thought no more of them till one day the red one happened right in my path, and, as it was too weak to run away, I took it up and found it was very light, just skin and bones, but healthy-looking in the eyes, so I took it to the house and fed it, and it soon got all right, and playful. Then I formed a theory—viz., that if such a starved thing as that was had taken the disease it could not have survived, and that possibly red cats were proof against distemper. This one was reared in a nest where I knew there was sickness, and I think all the rest of the family died; so that this survivor must have been proof against it, for it quickly grew into a fine cat.

I had read in "The Origin of Species" that there was some ailment in Virginia that killed white pigs while black ones were exempt; and we know that something of the same kind happens with the men in fever countries. I also remembered a pet dingo in Victoria—quite a young thing—that never took sick though tied in an infected kennel where some other pups had died—and dingoes are about the same colour as those red cats, except the brindle markings. Perhaps it is immunity from this disease that controls the colour of the dingoes, and the immunity from the most fatal disease in a country may be the cause of uniformity of colour in the animals.

The colour of the zebras cannot be called protective, but I have heard they are proof against a poisonous fly that kills horses, though their widest difference from some ponies would be in their colours. There are no great varieties among zebras, and the variety of colour in our cattle may be due to our ignorance in killing those that may have been proof against disease. Thus we get a hint that colour may not be only protective, as naturalists hold, but may be the outward sign of internal difference that we know little about, and the idea is very like Nature's beautiful plans in everything. It is new to me in a wide sense, and I think if I had known it twenty years ago I could have made use of those red cats among the rabbits by experimenting and finding suitable mates for the red ones—perhaps tortoise-shells. Cats living wholly on rabbits are very liable to disease, and if it were not for that I think they would have been a match for the rabbits in the back country, because they catch them with the smallest expenditure of energy—by lying in wait for them—and are otherwise the most harmless animals I know.

Another instance of the relationship between colour and disease is the many white cats that are deaf.

In the *Otago Witness* of the 17th November, 1898, page 6, is an article on the "Wild White Cattle of Europe," which is very suggestive from the above point of view, because it points out their great antiquity and wide distribution in the countries most liable to cattle disease; and in one sentence it says, "Why a wild race of cattle could not be of a white colour no explanation is given." Professor Boyd Dawkins said "their white colour was fatal to the idea that they were a pure wild breed." Thus he evidently thought that colour was only for protection, and gave no indication of constitutional differences. But those white cattle, or many of them, may have been proof against some fatal disease in that great extent of country which includes all the nations of Europe, and that may be the very reason of their wide distribution and long existence; and they may still be the fittest to survive all the diseases native to their country, even tuberculosis.

This suggests that the colour of those not taking sick in epidemics should be carefully noted and fostered, instead of adopting fancy colours in an arbitrary way, without rhyme or reason for them. There are often vagaries of colour amongst many animals, such as black sheep, black rabbits, yellow rabbits, piebald horses, &c., which we might make use of from the above point of view. The piebald horse might be the germ of the zebra's constitution if some one could only live long enough to work it up and make use of it in that country—that is, if experiments showed it to be hopeful.

In the cases of dogs and cats, where only a portion of the litters are reared, the constitutions that may happen to vary in the proof direction will survive if left to themselves, and that may be what causes the uniformity of colour in the *wild* animals, while we, in picking out the ones to save, may choose the very worst ones for the sake of some whimsical colour, and that is evidently why our *tame* animals are of so many different colours.

We test horses by racing and working them, and we breed from the best; but we have no constitutional test for cows, and it is therefore no wonder that they are subject to all sorts of ailments. A system open to severe correction by some epidemic like pleuro-pneumonia will leave the proof constitutions and give us a fresh start again. I remember when pleuro-pneumonia went through Victoria, and took about 70 per cent. of the cattle from the small farmers in the western district, and ruined many that previously thought themselves independent.

If colour does indicate constitution, even in a small way, the best individuals could often be saved and the others killed for beef, so that it would be of very great value to breeders if always kept in view. The colour of the American buffaloes,

the zebras, and many wild cattle and antelopes, could not have been for protection, and I think their uniformity proves that the colour in each case was the one that went with a constitution proof against their *own* epidemics.

The same might be said of the men in well-defined countries. Thus it follows that a given constitution might only be the best for its own country while fairly isolated, and that the frequent importation of foreigners may prevent the evolution of the healthiest race. For instance, the introduction of rinderpest to the South African cattle may seriously injure a fine race, as the measles injured the Fijians, and as some of our own ailments injure the Maoris. "Proof constitution" seems a clumsy term, but I noticed it used the other day by the Americans in picking out soldiers to stand the yellow fever. I do not know if they had any shade of colour to guide them, unless it might be what we call sun-browned, with the fact that they had previously escaped the sickness.

ART. LXXII.—*National Pensions—a Proposed Scheme.*

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Society, 11th July, 1898.*]

ALTHOUGH not openly manifested, there are few subjects of more interest to the public generally at the present time than the one which aims to provide pensions to the aged. Not merely in New Zealand, but in most countries possessing representative institutions the same idea has taken possession of many of those who pay attention to social growth, and view government as an evolution having in view the coming of the time when the richest shall be poor, and the poorest shall be able to live in abundance, as were those who dwelt in the Acadian land, on the shores of the Basin of Minas, as sung by Longfellow. But social reformers find that an apparent advance in the direction of freedom appears to have its corresponding disadvantages in the life-battle of humanity, which means, after all, "the struggle for existence." Man makes himself master of the forces of nature, and just as those forces widen the possibilities of human happiness, so, too, they widen the dangers of man's discomfiture in the great struggle that is in progress. By the utilisation of the forces of nature immense wealth has been accumulated. That wealth, do what we may, is daily and hourly being controlled

by fewer hands. Countries, equally with the several producers of wealth in them, are being done to death by those who have succeeded in appraising their own worth by a gold standard, no matter how the gold was obtained.

The hive of human working-bees was never so industrious in this world of ours as it is to-day, and at no other period was a single individual so capable of producing so much by the application of the arts and sciences to the industrial needs of mankind. And yet, with so much that makes for a promised time of comfort and contentment, it cannot be said that poverty is decreasing, and that those who toil will never be in want. Indeed, the various forms of benevolence that are to be met with the world over show that poverty is rampant, though wealth is equally rampant, no matter whether we take our standpoint to view the scene in the old or in the newer centres of civilisation and refinement. Poverty is rampant! And to show the truth of this in the richest country of the world it is only necessary to point out that in the year 1888 there were 825,507 paupers in England, while the sum of £8,626,164 was paid for their maintenance, or at the rate of £10 9s. per head per annum. In addition to this vast army of poor and needy, there were 157,103 paupers of the better class, but who are classed as pensioners, and are maintained directly out of State funds, and not from the rates. The cost of each pensioner was at the rate of £49 per annum, or nearly five times as great as that paid for each of the paupers, the total grant for pensions being £7,731,405.

It is not necessary to point out the conditions existing in the Australian Colonies, or in America, or Europe. The contrasts are equally as marked in those continents as in the case cited. Our own country, young as it is, has not escaped the blighting prospects of poverty in homes by a comfortless old age. As yet these aspects of our social life have not become so evident as in the Old World, but they are sufficiently marked to show that as years go by the contrast between poverty and riches is becoming more and more pronounced. Charitable Aid Boards, homes, refuges, industrial schools, and others are already in existence, and in 1895 the Government paid a subsidy on account of charitable aid amounting to £51,212, to which the sum of £38,907 must be added as the amount derived from rates. The number of inmates in the sixteen benevolent asylums of the colony at the end of 1895 was 1,169 males and 775 females, of whom 866 males and 261 females were over fifty years of age; whilst out-relief was given to 3,776 persons.

It would be useless to give the almost fabulous amount of wealth owned by England at the present time, and it is hardly necessary to show that the wealth of New Zealand is increasing

at a rapid rate. We have, however, the fact that poverty and wealth are existing side-by-side, and we have the further fact that if men have nothing they must either be helped or starve. Those who have must render aid to those who have nothing. The law recognises this among all civilised communities; and the fact that so much is paid away annually to meet the demands of poverty is sufficient to show that the laws under which we live must be seriously defective in some respect or other, as in England one in every thirty-five of those living in the country is forced to seek parish aid, and become dependent on his fellows for support, even though many of them are able-bodied, and capable of working under an intelligent and organized plan of government.

The world of commerce has grown out of the discovery of new lands, and just as commerce extended and gave rise to ambitious projects with a view to the acquisition of wealth, so a similar commercial enterprise has brought into existence banks, companies, insurance agencies, and the hundred and one schemes of traffic in human lives and property such as present themselves to the view of every man, woman, and child in the community.

The system of insurance, now so common everywhere, is of modern growth. Antonio's ships, in the days of the Venetian Republic, were not insured; but it would be difficult to discover a ship-owner in these days who failed to make provision in anticipation of the loss of his possessions through storm and peril. The same thing has taken root with respect to the safeguarding of household property and furniture and goods and chattels and crops—in fact, in these times it would be difficult to find an article of value that a speculative agent would not insure if he thought that a profit was probable by such a course. And now the insurance of human lives has become of special importance in every community. A human life is recognised as possessing value equally with property, and the various schemes devised for annuities, endowments, and payments to friends in case of the death of the insured, supply means to those in receipt of regular incomes of making provision either for old age or in favour of those depending on us. There is nothing difficult about the plan proposed, and, although insurance is merely a profit-making scheme on the part of companies other than those that are mutual and co-operative in their interests and profits, they nevertheless provide ways by which people in fairly comfortable circumstances can anticipate old age, sickness, and loss of employment.

But even these do not meet the needs of all classes of people. There are many thousands of people so circumstanced that insurance in its present form can never benefit

them in the least degree. The records of the different benevolent societies show this, for there are many families in every town where employment is so irregular and the weekly earnings so small that the household expenses cannot be met even by the exercise of the strictest economy. To go into debt is the natural course of such families, and even when times are brisk the debts that have to be repaid keep them one and all on the verge of absolute poverty. Provision for sickness, for old age, and for families in case of the premature death of the breadwinners cannot be made under such conditions. Hence it will be found that what is kept back under our present conditions from a large proportion of the poor has to be paid again in the course of time in the form of doles, whilst self-reliance, manliness, and self-respect are crushed by the process.

To engender habits of thrift and foresight among the poorer classes benefit societies were established, and perhaps no form of governmental control ever had so many possibilities of good as these self-reliant institutions. Friendly and benefit societies appear to have been an outgrowth of the old craft guilds which flourished in England for several hundred years, where mutual help, mutual responsibility, and mutual protection were their leading characteristics. Those who belonged to the craft guilds were allowed special privileges by the order. They were able to obtain loans without interest in case of need, and help was always rendered to the widows of members who had died. Thus we find Mr. John Hughes, Provincial Grand Master of the Manchester Unity of Oddfellows, in his evidence before the committee of the English House of Commons to inquire into the question of old-age pensions, expressing himself with respect to friendly societies in about the same way as a member of the ancient guilds would have expressed himself during the period of mediæval England. "They look," says Mr. Hughes, "upon a member of a friendly society as having done something to ameliorate the lot of his fellow-men, and make sacrifices. They do not expect to get their money back; they have no claim to get it back; they may pay for twenty or thirty years, and unless they fall sick they do not get anything."

Here we have the kernel, as it were, of Oddfellowship, and of all friendly societies now established. The abolition of the guilds and the confiscation of their funds by Henry VIII. and Edward VI. destroyed the exclusiveness of the various trades; but workmen thence became companions in a common aim and effort, and self-reliance manifested itself by the formation of friendly societies that recognised mutual help and mutual responsibilities under specified conditions. And any one who has watched and studied the growth of friendly societies throughout the world must have felt that they have been

a means of doing much good in the way of creating a self-reliant spirit among men, and in minimising the evils that must always be an attendant upon a system of individualism, as distinct and separate from socialism, which aims to minimise poverty and to raise man among his fellows, so that life may be at least worth living.

The friendly societies in New Zealand constitute an important factor in the promotion of thrift, if what has been quoted above is true. And no doubt there is a certain amount of truth in what Mr. Hughes stated. For example, a man joining the Order of Oddfellows, say, in Napier, at the age of twenty, as a participant in sick and funeral benefits, may be so fortunate as to have no sickness throughout life. If we suppose such a man to die at the age of sixty years, the only benefit derived by the payment of forty years' subscriptions would be the receipt by his wife or friends of a sum of £30. During the forty years the subscriptions would have amounted to £120, exclusive of special calls, which, compounded, would provide a large sum compared to the amount paid on the man's account. No doubt this is an extreme case, yet it illustrates the point that a member of a friendly society may do something to ameliorate the lot of his fellow-man by making a sacrifice. But sickness will make its appearance under all conditions of life, and unless provision can be made beforehand, as is done by members of friendly societies, those who are sick must either be neglected or they must inevitably fall into the helpless condition which is now the lot of many even in this country.

And yet, with so many possibilities in favour of friendly societies, it cannot, I think, be urged that the system is one that should be more generally extended. The admirable summary forming a portion of the statistics of the colony, as compiled by the Registrar-General, gives 30,905 as the total membership of all the orders of friendly societies in New Zealand, the three principal orders being the Independent Order of Oddfellows, the Ancient Order of Foresters, and the Ancient Order of Druids. I am not in possession of the detailed reports issued by the sixteen or more districts into which the colony is divided by the Oddfellows, but the valuation report of the Hawke's Bay District by Mr. Mason, the Registrar of Friendly Societies, contains some valuable and suggestive information, which, it may be assumed, will apply generally to the whole of the order. On page 5 the Registrar says, "The rate of secession is high. Of 735 members admitted before the quinquennium preceding the valuation twelve died. Of the remaining 723 members the numbers sick and not sick were 278 and 445 respectively. Of the 278 who were sick twenty-eight lapsed, being 10 per cent.; and of the 445 who

were not sick 191 lapsed, being 43 per cent. Of 599 admitted during the quinquennium preceding the valuation six died. Of the remaining 593 members the numbers sick and not sick were 120 and 473 respectively. Of the 120 who were sick thirteen lapsed, being 11 per cent.; and of the 473 who were not sick 126 lapsed, being 27 per cent." In other words, out of 1,334 members who belonged to the Order of Oddfellows in Hawke's Bay District at some time within a period of five years 358, or 27·2 per cent., left the order for reasons other than sickness. And yet the benefits offered are £1 per week for six months, 10s. per week the second six months, 5s. per week after a continuous sickness of twelve months; funeral, £20 on the death of a member, and £10 on the death of a member's wife.

But this fluctuating condition of membership appears to be far from uncommon. The annual report for the Hawke's Bay District I.O.O.F., M.U., for 1897 states that fifty new members were admitted during the year, whilst a hundred members ceased to belong to the order, of whom sixty-four had been in membership under five years, twenty-five had been over five and less than ten years, and eleven had been in the order over ten years and under twenty-three years. And why were so many members excluded from participating in the benefits offered by the order after payment of dues extending over such a long period of years? It is here that the trouble lies in friendly-society control, and it is in this direction also that the friendly societies scarcely fulfil the proud vaunt of Mr. Hughes to the committee of the English House of Commons in the words quoted above. Men who have been so many years members of a society that offers benefits such as are here stated could only have left because they were unable to pay their weekly or monthly dues, as the case may be, and such men are often too old or too poor to anticipate the future in other ways.

Life Assurance.—The business of life assurance as now carried on has an appreciable effect upon the friendly societies, and, judging by the number of policies current at the end of 1896, this form of thrift is largely adopted by the better class of colonists. There is no information available, as far as I am aware, to show how many of those belonging to friendly societies hold an insurance policy as well; but it may be assumed that, at least in the case of working-men, very few of such policies will be held. The 72,193 policies such as were current in 1896, with the 30,905 members belonging to friendly societies, give a total of 103,098 individuals in the colony, or, say, one in eight of the entire population who are known to be directly interested in making provision either for probable sickness, for old age, or for the benefit of those de-

pending upon them. But, whilst the growth of insurance is proceeding at a rapid rate, it appears that one in every fifteen of the total policies held lapsed during the year. Thus, according to the tables published by the Registrar-General, the total amount represented by the 72,193 policies current in the nine insurance offices doing business in the colony was £19,097,455 14s. 6d. This was exclusive of 5,338 policies discontinued, which represented £1,340,572 5s. 3d. It is a pity that information is not available as to the causes of the discontinuance of policies; but no doubt most of them may be set down, as in the case of the lapses in the friendly societies, to the "want of funds" to pay the necessary premiums at the time when due. In the above totals no account is taken of the ten thousand members who hold shares in one or other of the sixty-eight building societies in the colony. The aggregate value of the shares held by members was close upon half a million, which represents one of the channels used by working-men to place their savings in anticipation of future needs.

The Post-Office Savings-banks present a different field for inquiry from those already dealt with. This form of saving is largely used by the younger members of the community; and that the system is a popular one may be gathered from the fact that no fewer than 147,758 accounts were current at the close of 1896, representing deposits amounting to £4,311,634 13s. 5d., or an average of £29 3s. 7d. per head for each depositor. Here again the same difficulty presents itself as in the case of assurance and friendly societies. It is impossible to say how many of those having accounts in the Post Office are connected with building and friendly societies or hold assurance policies; but the facts presented are sufficient to show that a large proportion of the population are not merely provident in their habits and modes of living, but they anticipate the future in a way that will compare favourably with the people of any other country.

From the facts that have been stated here it will be seen that great efforts are being put forth by the people to provide in some way for the future. The amount may be insufficient to give all that is needed in the way of comforts in time of sickness and maintenance during old age, but there is sufficient evidence to show that even without the intervention of the State the people in this country are not unmindful of one of the highest duties of citizenship. Self-reliance and self-help are qualities in human character that should be fostered at all times; but, do what one may, there are times in the lives of many who strive to anticipate the future when they are unable to carry out their engagements, owing to circumstances that are perhaps unavoid-

able, and certainly unexpected. In the case of men who have joined friendly societies, or take out a policy of assurance, lapses may perhaps temporarily benefit to some extent the societies or associations to which they belonged, but it is at the subsequent expense of the public. In all matters relating to individuals there is a kind of compensating influence at work. You may take advantage of a man according to the circumstance under which he is placed in relation to yourself. Thus an advantage may be taken of a poor man by reason of the fact that he is poor. He must live, and his condition may be such that he must work for the barest pittance, just as certain Easterns do who are slaves of their masters. Modern society, mechanical and artificial as it has become, is in reality based upon scientific lines. Government as we know it to be to-day is the outcome of the sufferings and sacrifices made by individuals and societies and associations in the cause of freedom and enlightenment. It is organization and collectivism that have saved the individual as against oppression and poverty, and great importance should be attached to the inquiry how far organization has tended to improve the conditions of the workers.

In all the papers I have perused on thrift and pensions nothing has been said as to the effect of trade organizations in conjunction with the specialisation of labour upon individuals and wages. For example, let us take the case of a hundred workmen engaged, say, at a sawmill in this town, and a hundred workmen engaged as labourers or occasional station-hands. The former have regular work, and they become subject to regulations which require them to anticipate the morrow. Their habits are moulded to the conditions under which they work. As associates, the men are able to discuss subjects that affect their interests, and it will be found that the large majority enter one or other of the friendly societies in the town. But what of the hundred labourers and occasional station-hands, whose home life is entirely absent? How are they circumstanced, and how many of them are there who join an association for mutual intercourse and benefit? The question is one that bears directly upon the inquiry as to whether anything should be done for men in the aggregate. There are usually in the Old Men's Home in this town forty-five men, their ages varying from fifty-five to seventy-five years. Of those now in occupation, thirty-eight are over sixty years of age and seven below sixty. All of them have been accustomed to irregular employment, and the large majority are the product of the sheep-stations. These are facts which can be easily verified at the present time, and they go to show the importance of organization in trades and professions. How many, for

example, are to be found in the old men's homes in New Zealand who have been trained as engineers or blacksmiths or teachers or lawyers or ministers of religion? Such trades and professions are in a large measure specialised, and wherever specialisation comes in so also do better pay and improved social surroundings.

It may not be considered necessary to do anything in the way of helping a whole community at a certain time of life in the face of such facts as have been given as to the position of friendly societies, insurance, building societies, and Post-Office Savings-banks. These aspects of thrift, be it remembered, are as much socialistic as individualistic. They are individualistic inasmuch as each individual acts on his own responsibility in taking care of his surplus income on earnings, but they are socialistic because the savings are transferred to the keeping of societies or companies or Governments, as the case may be. By this means it is possible in a great measure to estimate the savings of the different classes of workers in the colony, and no doubt a large proportion of the working-classes endeavours to make provision for the future whenever opportunities are favourable. It must be evident, however, that many of those employed in the manufacturing industries of the colony are unable to do more than keep themselves in fair comfort, and put by for a time of need inconsiderable sums.

The average annual wage of 22,986 males employed in the manufacturing and machine works of the colony in 1896 was £77 5s., or at the rate of £1 9s. 8¼d. weekly for each worker; 4,403 females received in wages during the year £131,516, or at the rate of 11s. 6d. weekly. The return from which these facts are taken does not give the number of youths included, and whose wages are necessarily much smaller than those paid to adults. The annual report of the Minister of Education, referring to salaries, says, "The average salary paid to the 3,426 teachers employed in the public schools was £93 8s. 5d.," but the return included 1,061 pupil-teachers and 804 juniors, none of whose salaries would probably reach more than £60 per annum, whilst many of them would receive £20, or, at the most, £30, per annum. What is specially defective in these returns is the absence of information as to the purchasable comfort obtainable on the wages received, and the capacity of the workers to provide for old age. No information is available as to the wages paid to labourers and those subject to irregular employment, but the income is much smaller on the average than the above. In any case, it may be set down as a law that the nearer you get to unspecialised and non-professional forms of labour the nearer you get to poverty and to the condition of life that requires all the

powers of the workers to keep out of debt, without hope or possibility of saving either for sickness, for times of no work, or for old age.

This aspect of the question must be kept steadily in view. Our social conditions, by which I include our methods of employing labour, are such that no sooner has an employer of labour taken the best he can out of an employé than the latter is sent away to seek employment elsewhere. Those are the best servants who can produce the greatest profits for their employers, and so soon as profits diminish the workers suffer, because capital must be sustained at all costs. What I specially wish to bring out to view here is this: that, you may do whatever you please in the way of government, you cannot take advantages from one class and give them to another unless at the same time you make the class from whom the advantages are drawn more dependent upon others. It is the same in everything. You cannot destroy force or matter, neither can you destroy equity or justice. You may disturb the equilibrium by creating advantages, but these advantages carry with them responsibilities and after-effects which finally bring about a balance of conditions.

We have seen the average wage paid to those forms of labour where employment may be said to be constant, but there exists a large class in the colony who have no regular employment, and who depend for employment upon sheep-shearing, fencing, and the other hundred kinds of needs that spring up in a new country. No average wage can be obtained for this class of workers. Such labour may be well paid, but it is irregular, and I think that two hundred days a year may be set down as the extreme limit of employment during a year in which such men are engaged.

You have only to visit the Old Men's Refuge in the town to discover the source from whence the greatest troubles spring. Nor can anything else be expected under the present social conditions. Inquire from the old men as to their pleasures, their enjoyments, and their wanderings, and it will be found that when not employed they had to travel from township to township and from station to station, and the only place for shelter was the bar-room of the hotel, or a friendly wind-beaten whare by the wayside. No wonder such men break down under trials of mind and body to which most of them are exposed; and, whatever may be said of their failings, one is surprised why so few of them give up in despair, considering the black and prospectless lives through which most of them pass. Can such a class of men be expected to provide for a rainy day in the same way as the professional classes and those of the artisan class whose labour is regular? If not, what ought to be done, not merely to train them in

habits of self-reliance, but to stay the increasing tendency to seek charitable aid at the hands of members of the twenty-one District Boards into which the colony is divided for the purposes of doling out relief?

I have pointed out already that when a dole is given by the State to individuals it is known as a pension, but when given by unions in England or by Charitable Aid Boards in New Zealand it is a relief or a charity; but to me the man who has passed through life "toiling, rejoicing, and sorrowing," like the village blacksmith, is as worthily entitled to a pension at the instance of the State as is the man who has been employed in the destruction of mankind at the instance of a Government, or in writing letters for a Minister of State, who draws the pay and then expects the people to pension his overworked clerk.

It is clear from what has been already stated that the social conditions of a country are such that, no matter what plan may be adopted, whether the individualistic or communistic, in government, there must be, and there always will be, differences in the comforts and possessions of the people. As well expect an equality in the production of the soil as expect the same results to obtain among human beings. But, whilst this is recognised, it should just as fully be recognised that an organized society implies a capacity to regulate for the common good. All government is assumed to recognise this, and jointly in its individual and collective capacity is supposed to provide for it. Whatever scheme of social evolution there may be as the years go by, there will be rich and poor just as certain as there will be summer and winter.

Now, the facts that have been presented show that so soon as people have the opportunity to save in anticipation of a rainy day they do so, and most of the agencies and profit-making schemes of these latter days are the outcome of this growing tendency among men to provide for bad times and sickness and old age. The friendly societies have done good work in their days, and the insurance agencies have likewise been a great power for good in paving the way to a generalised scheme of benefits to communities.

The principle laid down as regulating the trade guilds has, in a large measure, been followed by every society and association having in view the case of man's bodily needs, but, unfortunately, such institutions have been based on the management of an ordinary joint-stock company, where a man's profits are in proportion to the amount of money he has at stake. Just as the friendly society was the outgrowth of the trade and craft guilds, so insurance is the outgrowth of the friendly society, the commercial system, and the factory system, and now the tendency to generalise yet more is

becoming apparent. From the individual to the family, the family to the guild, the guild to the society, the society to the community, the community to the State, such is the evolution of human interests in the history of every people when passing from individualism to communism, or from savagery to a highly organized form of government.

The late Sir Arthur Helps, in his book on "Social Pressure," says of government, "I believe it to be true that never is paternal government so needful as when civilisation is most advanced. The more advanced the civilisation the less powerful is the individual, and the more he requires to have a careful father, who should look after him and befriend him. He has become a part of a machine, and there is great need that the regulator of the machine should be a living, acting, forcible creature, who should have a feeling for all the separate portions of the machine he regulates." We have in these few lines the gist of the whole matter. The individual is beset with so many opposing interests in a highly organized society that in reaching a certain social stage he sinks to a mere cipher, as a potent factor in the race of men. He cannot climb, and, if he would, finds every walk of life graded in such a way that advance is almost impossible. We have seen that there are people in the colony who under the present social conditions cannot possibly save from their earnings. They are ready to work, and capable of working. What ought to be done with men of this class? And yet such people are happy compared with thousands and tens of thousands of workpeople in England and other lands where a highly differentiated stage of social life exists, and as time goes on this condition will manifest itself with us as the introduction of manufacturing industries goes on under free competitive conditions.

Already there is a tendency to the lowering of the average earnings of factory-hands. In 1891 the average earnings of 29,880 persons who were engaged in industrial work in factories and workshops amounted to £73 19s. per head per annum. At the end of 1895 the average earnings had fallen to £69 13s. 11½d.; the male workers showing at the same time a diminution of 14·6 per cent., whilst the females increased 48·3 per cent. The same tendency to a lower average rate of pay, owing to competition, is manifested among teachers, and no doubt the professions generally have experienced a similar tendency. But with these facts before us, and seeing that such organizations as are now in operation for making provision against sickness, &c., are simply the outcome of a desire among individuals who were weak to protect themselves against some form of injustice, is it not possible for the State, as a big father, to come to the help of

the individual, and befriend him, without the cruel system of pauperisation, such as is adopted in the Old Country, and which is the direct product of the feudal system?

We in this country ought to be sufficiently capable of determining for to-day and to-morrow whether the poor-laws of England have or have not been a failure, and whether they should be allowed a foothold amongst us. In feudal times the destitute were helped by the monastic and religious organizations as a duty, and that duty was carried out until the spoliation of the monasteries by Henry VIII., who also confiscated the possessions of the trade guilds. From then till now there has been an increasing tendency to organization among the workers and the masses as a means of preserving themselves and their interests against an aristocracy of wealth possessing almost unlimited powers. In 1536, so bad had grown the state of affairs, that the Parliament enacted that voluntary alms should be collected in every parish for the purpose of relieving impotent poor. A similar Act was again adopted in 1555; and in 1563 another Act was passed, making it competent for the Justices and churchwardens in petty sessions to tax any obstinate person who refused to give willingly a weekly aid to the relief of the poor—such sum as in their discretion they deemed proper and just. This state of things continued till the celebrated poor-law of 1601, by which relief was provided for those who could not work—"the poor by impotence"; work for those able and willing—"the poor by casualitie"; and imprisonment for the idle—"the thriftless poor." Under our system there ought never to be indigent poor such as are to be met with in England. Our institutions are not based upon feudal tenures, and our social and political institutions recognise the fullest equality between man and man.

"Life, liberty, and the pursuit of happiness" are unalienable rights, and the aim of a community living under democratic institutions should be as the aim of a parent who has a family to train and to regulate. Organization is the leading characteristic of good government, and whilst in the production of wealth the individual has full scope for the exercise of the powers, the State, as a wise and careful parent, should safeguard and regulate those interests which affect the lives and well-being of each individual. We have seen how under our present social arrangements a large proportion of those in friendly societies who aim to insure against times of sickness or old age lapse or fall owing to causes beyond their own ability to prevent, and the same thing takes place under the various assurance schemes in operation. Under a properly organized scheme such "lapses" would be impossible, and the question arises whether the time has not come to

inquire as to the feasibility or otherwise of adopting such a scheme as may benefit the people as a whole in such a way that sickness and old age may be met without anxiety. As a people we recognise the great advantages of one scheme of taxing, the one authority in government.

The State exists ostensibly for the same ends as did the trade guilds, and there should be no greater difficulty in formulating a mutual and general pension scheme for the benefit of every citizen than in formulating a general scheme of taxation which implies an equity of payment in return for an equity of protection. For my own part, I do not see the slightest difficulty in the way, for if you concede the possibility of arranging an equitable scheme of taxation, the like principle is involved in arranging for an equitable scheme to provide for participation in sick benefits and in pension benefits at a time of life when, through physical infirmity of any kind whatever, citizens are unable to maintain themselves by physical and mental labour.

Twenty-two years ago I was one of a deputation of teachers to my respected friend the Hon. Mr. Rolleston, M.H.R., who was then Superintendent of the Province of Canterbury. The object of the deputation was to establish a pension scheme for teachers. As secretary, and having made a study of the question, I proposed a scheme which provided that every teacher in the public schools should from the time of entry as a pupil-teacher be required to pay a certain percentage of his salary into a fund, to be known as the "Teachers' Benefit and Superannuation Fund." Should a teacher die before the age when a retiring-allowance became necessary his widow—if he was a married man—was to receive certain benefits as long as she lived or remained single. Although favourably received by Mr. Rolleston, the time was not favourable, as provincialism itself was on the point of extinction, and nothing was done; but from that time till the present I have many times urged the adoption of a scheme such as would be of use to teachers in case of sickness or of compulsory retirement from duty. In my annual report to the Education Board in December, 1888, occurs the following: "Before closing my report, I desire to bring under the notice of the Board a subject which closely concerns the welfare of teachers and the success of education. The Board is aware that the large majority of teachers are in charge of schools, or occupy positions, from which the income obtained is none too large to sustain a family in comfort and provide a death contingency in the way of life assurance. Very few, I fear, among the teachers in the smaller schools are able to make any provision for coming old age. Within the past three years two sad

cases have come under my notice as occurring in this district. In one case the master had to resign his appointment in consequence of loss of eyesight, and he is now a poor old man subsisting on the charity of friends. In the second case the master had a serious complaint, which really incapacitated him as a teacher, but his circumstances were such that he was forced to continue to remain in charge of a school until the ground almost closed over him. These men possessed satisfactory qualifications; they had spent their lives as teachers in the service of their country, and their moral characters were of the highest and best. Is it not possible for something to be done to help such a class of deserving men in time of need? Some years ago the question of a teachers' superannuation fund was mooted, and this, I imagine, would have been carried into effect had not circumstances necessitated the expenditure of the accrued school fund for school-buildings. To me there appears little difficulty in the way of establishing some such fund for teachers, if the central department would take the initiative. The retention of 1s. per head of the capitation-allowance now paid to Education Boards for school-maintenance would provide at once, and in the most equitable way I know, a fund sufficient to meet the cases of all teachers who, through ill-health or increasing years, find it necessary to retire from the profession."

Since these lines were first written there has been a remarkable impetus given to the question of State pensions, and in Germany legislation has taken place, known as the "workers' insurance legislation," which provides the working people of Germany with three kinds of compulsory insurance, the first being to make provision against sickness. This fund is controlled by the people themselves. The second fund provides for insurance against accident; this is controlled by the employers of labour. The third fund provides for the granting of old-age pensions, on account of disablement or old age. There the State steps in and controls.

In England several important schemes have lately been proposed, among which may be mentioned one by Mr. Charles Booth and one by the Right Hon. Mr. Chamberlain. Mr. Booth proposes that every inhabitant of the British Isles, on reaching the age of sixty-five, is to receive as a right the sum of 5s. a week until his death, unless he or she has in the ten years before that age been in receipt of poor-house relief, or has been convicted of crime. Mr. Chamberlain's scheme differs widely from the above. He proposes to establish a State Pension Fund. The payments to it are to be voluntary. There are for men tables of payment in a returnable and non-returnable scale. Thus on a returnable table a man who before his twenty-fifth year pays £5 to the Post-Office

Savings-Bank is to be credited with a further sum of £15 from the State Pension Fund. Afterwards he has to pay £1 a year, and at sixty-five he can claim a pension of £13 a year. There are certain provisions for allowances to his widow in case of death, and should he die without leaving a widow or children his representatives receive the original £5. In the case of a woman payments have to be made on a non-returnable scale. £1 10s. deposited in the Post-Office Savings-Bank before twenty-five years of age entails a credit of £8 from the State Pension Fund, and thereafter on the payment of 8s. 8d. yearly for forty years a pension of £7 16s. is due at the age of sixty-five. Thus on this scheme a man is to become entitled to a weekly payment of 5s. at the age of sixty-five, and a woman to a payment of 3s. a week at a like age.

The Act to provide old-age pensions which was introduced by the Right Hon. Mr. Seddon last year states that, "Whereas it is expedient that all persons who during the prime of life have helped to bear the public burdens of the colony by the payment of taxes, and to open up its resources by their labour and skill, should in old age be protected by the colony against risk of want: Be it therefore enacted that every person attaining the age of sixty-five or upwards shall be entitled to a pension of 10s. a week for the rest of life if he is and has been for twenty years residing in the colony continuously for the preceding three years and not more than eighteen months absent in ten years preceding application." It is proposed to find the necessary funds to meet such a liability from the following alternative services: Primage duties, increase of excise duties, land-taxes, death duties, and stamp duties, tax on mortgages, ticket-tax on entertainments, &c.

It will be noticed that the schemes mentioned vary very widely. The German scheme calls in the combined assistance of the workers, the employers of labour, and the Government; Mr. Booth's scheme makes the State liable for the maintenance of all persons over the age of sixty-five years; Mr. Chamberlain's scheme combines workers and the State; whilst Mr. Seddon's scheme runs on all-fours with Mr. Booth's, except that the proposed pension is doubled.

With the schemes proposed for England we have nothing to do. They are suggestive, as in the German scheme, but they would certainly not be satisfactory if adopted for this country. The standard of social comfort is much higher in the colonies than in the old countries of Europe, and when it is considered that the average cost for the maintenance of paupers in England is already 4s. weekly, Mr. Chamberlain's scheme offers nothing to the workers beyond paying for a period of forty years for what they obtain at present for nothing.

The proposal for the aged of New Zealand is a liberal one, but it lacks what appears to me as the essential element in all government—viz., self-reliance. The men are to receive a pension because they have lived in the colony for a period of twenty years. The various duties proposed to meet the cost of the scheme barely affect the majority of those who would most likely become participants; besides, the age is fixed at sixty-five. No provision is made for sickness or for cases where physical infirmity compels the retirement of persons from labour at an earlier period. The aim of any scheme that may be adopted should be to destroy all charity organizations such as now exist: they are a blot upon our modern civilisation, more particularly so when the civilisation is based upon democratic forms of Government such as the colonies possess. This may readily be done by requiring every individual, whether male or female, working for wages, to set aside from the day he begins to labour at remunerative employment a small amount daily. This amount should be deducted by the employer and paid into a Government sick and pension fund account at stated periods. Every worker should be provided with a check-ticket that should be entered monthly by the employer, and removal from one district to another should make no difference to the worker. The amount to be deducted should not exceed 1d. daily, or £1·6s. 1d. in a period of 313 working-days. This, of course, would be the maximum amount payable. When not employed no payment would be made, as it is manifestly unfair to ask those who are earning nothing to pay the same dues as those who are earning wages. This system might not produce an amount sufficient to provide all that would be wanted for sick and pension benefits, but, at any rate, it is a self-reliant scheme, and one which recognises to the full mutual support, mutual protection, and mutual responsibility.

And now let us see how such a scheme would be likely to work. The population of the colony over fifteen years and under sixty years of age, in April, 1896, was 409,829—viz., 218,769 men and 191,060 women; between the ages of sixty and sixty-five years there were 16,782 persons—viz., 10,504 men and 6,278 women; and over the age of sixty-five there were 20,756 persons—viz., 12,503 men and 8,253 women. In other words, 8·3 per cent. of the population over the age of fifteen years, or 1 in 12, were over sixty years of age; 4·6 per cent., or, say, 1 in 22, were over sixty-five years; and 3·7 per cent., or 1 in 27, were between sixty and sixty-five years of age. I do not suppose that at any time or period one-half of the men and women over the age of sixty are incapable of pursuing their accustomed calling. But for the sake of an illustration let it be assumed

that one-half of the 37,538 persons over sixty years of age—viz., 18,769—were to claim their pension of 10s. weekly, or £26 per annum, the sum required would be £487;994. According to a letter from the Commissioner of the Government Life Insurance Department relative to the annual payment necessary to secure a pension of £26 a year on and after the age of sixty-five, it appears that an annual payment of £1 11s. commencing at the age of eighteen would suffice to secure an annuity of £26 a year payable at the age of sixty-five, interest being estimated on a 3-per-cent. scale. Now, if the payments of 1d. a day for every working-day was to begin as suggested by me—viz., so soon as young people begin any form of employment—*i.e.*, at an average of fifteen years—it will be found that on a 4-per-cent. scale the payment of £1 6s. 1d. per annum would be sufficient to provide an annuity of £26 a year, payable at sixty, or at such period afterwards as the recipients might desire. As for the time of retirement, the question should be an open one, depending upon physical capacity, as there are many men to be found in the colony who are physically and mentally more capable at the age of seventy than are others at the age of fifty-five.

The interesting return by the Registrar of Friendly Societies which was made last year, pursuant to section 19 of "The Registration of People's Claims Act, 1896," for old-age pensions, shows that 8,018 persons in the colony—viz., 5,602 men and 2,408 women—over the age of sixty-five years sent in a claim to be registered as entitled to participate under the proposed Act; 5,584 claims—equal to 26·9 per cent. of the total over sixty-five years of age—were admitted, the others being either rejected or deferred for further information and inquiry.

Now, the number of claims differs very little from what might have been expected under ordinary circumstances. The claims from the women were perhaps fewer than might be expected under ordinary conditions, but of the 20,756 persons over the age of sixty-five years in the colony certainly not more than one-half might be expected to lay claim to a pension at any period under the conditions laid down.

In England 12 per cent. of the population over sixty years of age are in receipt of parish relief, and no doubt a large percentage are on the verge of poverty, but prefer to remain dependent upon outside charity rather than have the stigma of pauper attached to their names and homes.

It has been pointed out already that of the 447,367 persons in the colony over the age of fifteen years 409,829 are between the ages of fifteen and sixty. One penny daily deducted from the earnings of each for 313 working-days would give an income of £534,485 4s. 9d. If, now, we assume

that one-half of those over the age of sixty years would become claimants for a pension under the necessary conditions of granture—a proportion much higher than may be expected —the total liabilities would be £487,994. Thus between possible income and expenditure there is a large margin sufficient to provide contingencies for special cases, and arrange for yet wider benefits in the way of a sick fund as the system becomes more firmly established.

The scheme here suggested has the merit of being mainly self-sustaining and self-supporting. Every participant of a pension will have provided during the course of years an endowment for himself or herself, and it will not be a question of poverty bending as a suppliant at the footstool of charity, but it will be old age living in peaceful comfort and content as the outcome of prudential conditions and foresight exercised by a paternal Government.

In the course of years the claimants would naturally increase, and the cost of maintenance would also increase by the sum of £26 for every such addition; but on such a population basis as I have quoted above there would be a corresponding increase of twenty-six or twenty-seven additional persons added to the number of those entitled to pay their 1d. a day into a pension fund, and thus the annual income available for expenditure would be increased even at a greater rate than the proportionate increase of claimants. Under the German system of pensions a condition is attached to the effect that pensions are not subject to pledging, mortgaging, or seizure of any kind. This of necessity would be required under any scheme, as the aim of a generalised scheme is to do away with all those forms of charity which debase humanity, and are a blot upon our modern civilisation. A pension should suffice for fair comfortable maintenance.

No charity should intervene in the case of pensions, and should it be found that any pensioner abused the privilege of his pension he should be dealt with as is done so successfully in the case of children committed to industrial schools. The boarding-out system has proved highly valuable as a means of training children, and old pensioners who are thriftless might well be "boarded out," the maintenance allowance being paid directly to those who undertake their charge.

The system which I have been compelled so briefly to outline does not affect in the slightest all those forms of thrift such as are open to the public at present. Friendly societies may go on in their own way, assurances may continue to be effected on the lives of the people by the various companies now doing business, and all forms of thrift—such as building societies and savings-banks—may do their part in taking charge of the surplus moneys of the workers and the thrifty.

It differs from a scheme that has been proposed, inasmuch as it makes the people the direct agents and sustainers of their own schemes and their own pensions.

I am aware that much may be said in favour of the proposal to issue pensions to individuals in a country over a certain age simply because they have been citizens of that country for a number of years; but just as in the time of the poor-law of Elizabeth there were "the poor by impotence," "the poor by casualitie," and the "thriftless poor," so these three kinds of poor may still be found. The thriftless poor will be forcibly trained to anticipate the coming years under the system suggested, and it is only by some such scheme that habits of prudence and foresight can be enforced for the common benefit and good of all.

Two hundred years have passed by since the first workhouse was established in Bristol by John Cary. It can hardly be said that such houses have trained a large proportion of the people in anything but dependence upon others. Self-reliance, manliness, foresight, thrift, have all been wanting under such a well-meant though impotent plan; and it is the duty of every citizen in this country, freed as he is from the restraint of custom, to insist that such charity methods as have sprung directly from the abolition of feudal tenures, the grasping by kings and their favourites of monastery lands, and the confiscation of the properties of the craft guilds, shall not find a footing in New Zealand. Our country is free from the incubus of army maintenance, which in England costs treble a pension scheme; and, perceiving the deficiencies and weaknesses that exist in the social schemes of older countries, it is our duty to exercise judgment in the selection of modes of living in such a way that our land and our people may be like the Acadian land and the Acadian people of whom the poet sings, where "the richest were poor, and the poorest lived in abundance."

Summary.

The following summary gives, in brief, the reasons for the adoption of a national pension scheme, and the benefits to be derived therefrom:—

1. Our social conditions differ from those of older countries like England.

2. Our political conditions are different.

3. It is the duty of people to anticipate the future.

4. The State is a gainer or loser in proportion as the interests of communities and individuals are fostered.

5. For all purposes of mutual interest and benefit the State can do things better than individuals—*e.g.*, post-office, telegraphs, taxation, education.

6. Competition is so strong, employment so uncertain, and wages so diverse that direct provision for sickness, bad times, and old age is impossible to a large proportion of the population in every community.

7. Poverty is not a crime, and old age and poverty are certain under our present social and commercial systems.

8. Charity organizations, poor-houses, refuges, are unworthy of our enlightened civilisation.

9. People should be trained by the State to anticipate the future, and schemes should be devised having this end in view.

10. Friendly societies and assurance companies offer certain benefits, but they are open to serious defects such as a State system only can amend.

11. No system other than one established by the State could confer pensions and destroy charity such as is now recognised by the general and local government authorities.

The advantages of a pension scheme such as is proposed are:—

1. Self-reliance and independence are fostered among the people.

2. It is equitable and self-sustaining.

3. It treats men and women on terms of equality.

4. It gives independence to individuals at a time when least capable of opposing the influence of capital and companies.

5. It binds the classes and masses together in such a way that individualism and socialism may work together for the common good.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

Thirtieth Annual Report.

Meetings of the Board were held on the 3rd September, 1897, and 11th February and 8th September, 1898.

Messrs. T. Mason, E. Tregear, and J. Young retired from the Board, in compliance with clause 6 of the Act, and were reappointed as Governors of the Institute.

The following gentlemen were elected to represent the Incorporated Societies—viz., Mr. S. Percy Smith, Mr. J. McKerrow, and Major-General Schaw—in accordance with clause 7 of the Act.

The members now on the roll are: Honorary members, 28; Auckland Institute, 167; Hawke's Bay Philosophical Society, 66; Wellington Philosophical Society, 146; Philosophical Institute, Canterbury, 77; Otago Institute, 103; Nelson Philosophical Society, 20; Westland Institute, 57: making a total of 664.

The New Zealand Institute has lost two active members—Messrs. T. Kirk and W. M. Maskell—during the year, both of whom have served on the Board of Governors, and were the pre-eminent leaders for the whole colony in the special branches of science to which they devoted their talents and industry.

Thomas Kirk was everywhere recognised as our foremost botanist, and it is almost an irretrievable loss to science that his career should have been cut short when in the midst of a great work on the botany of New Zealand. The portion of the work that was in print at the time of his death covers descriptions of the flowering-plants as far as the end of the natural order Compositæ. This is equal to rather more than half of the first volume of Hooker's Handbook. These sheets, containing 363 pages, have been submitted to Sir Joseph Hooker for perusal and comment, and it is hoped that satisfactory arrangements will be made for completing the work. In the meantime it is proposed that Mr. Kirk's portion should at once be published under the superintendence of his son, Mr. H. B. Kirk, who is thoroughly qualified for the task. Besides his great and

standard work on the New Zealand Forest Flora, the late Mr. Kirk contributed 122 botanical papers to our Transactions, and supplied numerous papers for publication in the *Journal of the Linnæan Society*, London, the *Gardener's Chronicle*, *Nature*, *Journal of Botany*, and the *Journal of the Linnæan Society of New South Wales*. In his official capacity as Commissioner of Forests he made botanical explorations in every part of the colony, and no other botanist has ever acquired such a complete familiarity with the New Zealand flora, and particularly with the geographical distribution of the various species of plants.

William Miles Maskell will be greatly missed by all workers in the special branch of entomology which deals with the most difficult family of Coccidæ or scale-insects. The laborious study of these insects is of great economic importance, as they are the cause of the blights which are now spreading rapidly all over the world and tending to the destruction of the fruits of labour in the field, garden, and orchard. Mr. Maskell took up the subject twenty-five years ago, after the death of Signoret, and his name is now famous throughout the world as the best authority on it. It is a very tedious branch of study to prosecute, requiring the most delicate and precise microscopic manipulations. He did it all in his spare time, of which he could not have much, as since 1875 he has been fully occupied, and in late years, it is to be feared, overworked himself in the performance of his duties as Registrar of the New Zealand University, the official organization of which he worked up almost single-handed from its inception to the large proportions it has now attained. The enormous amount of work he did in his special studies is evidenced by his standard work on the New Zealand scale-insects and the series of elaborate and beautifully illustrated memoirs, twenty-four in number, which he has published in our Transactions during the last thirteen years. He has also left an enormous collection of specimens and microscopic preparations, the great majority of which are original types of species he described. These include cabinets containing over a thousand species of named Coccids; over thirteen hundred mounted specimens for the microscope of Coccidæ, Desmidieæ, Algæ, and Diatomaceæ; 750 named but unmounted species of Coccids; manuscript books containing a catalogue of Mr. Maskell's collection; Signoret's Essai sur les Homopteres-Coccides, 1867 to 1875, with an analytical index by Mr. Maskell in manuscript. Specimens were transmitted to him for identification or original description from all parts of the world, and the accumulation of specimens and correspondence since he became incapacitated for work in January last is very large, and awaits the attention of an entomologist who will continue

Mr. Maskell's good work in this most important branch of science.

"Maori Art": The publication of this work is progressing as rapidly as circumstances will permit. Part II. was issued in October last, and Part III., which treats of Maori weapons, implements of agriculture and handicraft, the snares and implements used in hunting rats and birds for food, list of words used in connection with the subject, and plates with descriptions, is now published. On revising the large amount of material accumulated by Mr. Hamilton on the "Habitation of the Maori," it was found necessary to make Part II., which relates to that subject, a double part, which will slightly increase the cost of the whole work to subscribers. The work has everywhere been received by most favourable reviews and cordial recognition as a contribution to anthropology of the highest merit.

The volumes of Transactions now on hand are: Vol. I. (second edition), 233; Vol. V., 8; Vol. VI., 15; Vol. VII., 98; Vol. IX., 98; Vol. X., 129; Vol. XI., 27; Vol. XII., 29; Vol. XIII., 30; Vol. XIV., 53; Vol. XV., 164; Vol. XVI., 164; Vol. XVII., 163; Vol. XVIII., 135; Vol. XIX., 154; Vol. XX., 155; Vol. XXI., 87; Vol. XXII., 89; Vol. XXIII., 163; Vol. XXIV., 167; Vol. XXV., 167; Vol. XXVI., 173; Vol. XXVII., 176; Vol. XXVIII., 180; Vol. XXIX., 450; Vol. XXX., not yet fully distributed.

The volume (XXX.) just published contains sixty-eight articles, together with addresses and abstracts which appear in the Proceedings. The work consists of 638 pages and 45 plates.

The following gives a comparison of the contents of the present volume and that for last year:—

	1898. Pages.	1897. Pages.
Miscellaneous	138	178
Zoology	245	154
Botany	66	208
Geology	31	32
Chemistry	28	18
Physics	28	...
Proceedings	54	45
Appendix	48	45
	638	680

The cost of printing Vol. XXIX. was £433 6s. 9d. for 680 pages, and that for the present volume (XXX.) £416 15s. 9d. for 638 pages. This includes the preparation and printing of the plates.

The treasurer's statement of accounts shows that the

receipts for the year were £767 12s. 7d., the expenditure £767 12s. 7d.

The amount appropriated for the publication of memoirs and postponed papers is now £612 16s. 3d.

Reports are appended showing the work done in the Departments of Meteorology, Time-ball Observatory, and Museum.*

JAMES HECTOR, Director.

3rd September, 1898.

Approved by the Board.—THOMAS MASON, Chairman.—8th September, 1898.

NEW ZEALAND INSTITUTE ACCOUNTS FOR 1897–98.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand, 3rd September, 1897 ..	3	8	11	Printing Vol. XXX. ..	416	15	9
Vote for 1897–98 ..	500	0	0	Expense of publication of "Maori Art" for year	308	19	7
Contribution from Wellington Philosophical Society	17	13	6	Publication of Mangareva vocabulary ..	16	8	0
Sale of volumes of Transactions, Trübner, &c.	43	10	7	Expense of library ..	6	6	0
Sale of Parts I. and II., "Maori Art" ..	45	14	0	Foreign postage, stationery, and miscellaneous	19	3	3
Advance against Deposit Account ..	157	5	7				
	£767	12	7		£767	12	7

WM. THOS. LOCKE TRAVERS,
8th September, 1898. Honorary Treasurer.

* These reports will be published in a separate form.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *29th June, 1898.*

Mr. E. Tregear, President, in the chair.

It was announced that, in conformity with the rules, Mr Martin Chapman and Mr. E. F. Hawthorne had been placed on the Council in the room of the late Mr. T. Kirk and Mr. W. M. Maskell.

A copy of Vol. XXX. of the "Transactions of the New Zealand Institute" was laid on the table.

The President delivered his address. (*Transactions*, p. 605.)

Sir James Hector proposed a vote of thanks to the President (Mr. Tregear) for his able address, which gave an instructive sketch of some of the salient advances in science during the past year.

This was carried.

Sir James Hector moved that the Society place on its records an expression of the deep sorrow which members feel for the loss of two of its most eminent and active members, Mr. Kirk and Mr. Maskell. Both had on several occasions been Presidents of the Society, and were the pre-eminent leaders for the whole colony in the special branches of science to which they devoted their talents and industry. (See Report of New Zealand Institute above, p. 707.)

Mr. Mestayer seconded the motion, which was adopted, the Council being requested to make formal entries on the records of the Society, and to forward copies with an expression of sympathy to the relatives.

Sir James Hector exhibited the following recent additions to the Museum, with notes:—

1. Further instalment of the shore fishes of Fiji, mounted in formaline, and presented by Sir W. L. Buller, F.R.S.

Unfortunately, it would be impossible to classify these fishes until a copy of Dr. Günther's memoir in the records of the Godeffroy Museum was available.

2. Chitons, both shell and animal, mounted in formaline, from Lyall Bay; presented by Miss Mestayer.

These had been submitted to Captain Hutton, who had named them according to the most recent classification.

3. *Siphonaria obliquata*, five specimens, with the animal mounted for anatomical examination, from Lyall Bay; collected by Miss Mestayer.

The internal structure of this animal was very interesting, as, owing to the form of the external shell, it was formerly classed with the limpets. It belonged, however, to the same group of *Pulmonata* as the curious shell *Amphibola*, which was abundant on all mud flats, but was peculiar to New Zealand, and apparently to very recent times, as, with one doubtful exception, it had never been found among the deposits of even sub-fossil shells. As its breathing apparatus and horny operculum connected it with land, marine, and fresh-water Mollusca, it was curious that a type so little specialised should be of recent creation.

4. Lemur (*Galago mokoli*), South Africa.

The smallest species of this interesting group of quadrumanous animals, most of which were peculiar to Madagascar. This one, however, was a native of South Africa.

5. Freshly mounted specimen of the great Arctic owl (*Nyctea nevea*) of North America, and of the great horned owl (*Strix bulbo*) of Norway.

SECOND MEETING: *20th July, 1898.*

Mr. E. Tregear, President, in the chair.

Papers.—1. "On Congenital Stigmata," by E. Tregear. (*Transactions*, p. 623.)

Sir James Hector said the subject was quite new to him. Congenital transmission and atavism of ephemeral skin-marking was well known among certain lower animals, but it became of great importance if such markings could be used for racial distinctions in the human species.

Mr. Hudson exhibited a fine collection of *Tipulidæ* (Daddy Long-legs), beautifully prepared by himself; about thirty or forty species.

The mosquito was shown, and it was stated that it was only the female that bites.

Mr. Harding exhibited a spider (*Salticus*) which was dangerous for fowls to eat; he also showed a spider-wasp (*Pompilus*).

Sir James Hector exhibited a specimen of the pipe-fish (*Sygnathus pelagicus*), from Queen Charlotte Sound, presented by Mr. W. T. L. Travers.

He said this species was scarce, and that this was the first of the kind received at the Museum.

Mr. Haylock said he had collected some, but not so large, and probably of a different species.

Mr. A. McKay exhibited and described a large collection of rocks and minerals, collected by him during the past two years from the Cape Colville Peninsula.

After sketching rapidly the geology of the district, he proceeded to describe the more important features of the collection. The andesitic rocks of the Tokatea Range, the Thames, and Karangahake were compared to show their general correspondence, and those of Kaipanga and Keven's Point, Coromandel, with the rocks of Maresville, Waitekauri, and Waihi. The Beeson's Island rocks were shown to be distinct, and present over a very large area of the southern goldfields of the district. The acidic rocks of the peninsula were shown to be largely developed along the east coast, south of Mercury Bay, and to occupy nearly the whole of the Upper Ohinemuri or Waihi Plain. Many samples of different kinds of quartz were exhibited, in evidence, it was claimed, that most of the reefs had been deposited by hydrothermal action, and in support of this cases were cited in which reefs of crystalline quartz could be traced until they passed into undoubted geyser deposits accumulated on the present surface of rocks of late Miocene age of the Beeson's Island group.

Sir James Hector said that Mr. McKay's magnificent series of rock specimens from the Cape Colville district would greatly increase our knowledge of this important goldfield. Even a superficial inspection of such large specimens would enable the cabinet student to acquire a better notion of the field geology than could usually be obtained from ordinary hand specimens. Large blocks also permitted of a much better selection being made for microscopic and chemical study. He did not altogether agree with the introduction of the terms "sphirulite" and "pearlite" as distinctive characters, seeing that they were structural forms of a variety of rocks. A most important point was mooted by Mr. McKay. All geologists were agreed that besides a core of ancient rock there were several succeeding series of igneous rocks belonging to widely different geological periods. As in other parts of the world, the core had formed the anvil against which the later-formed rocks were crushed, faulted, and impregnated with mineral veins. The last outbursts were certainly rhyolites, and if the suggestion that these were auriferous was correct it was difficult to see why goldfields should not extend over much larger areas of the North Island than yet discovered. Of course, the transfusion of the gold into rhyolite from the underlying rocks by solfatara action would account for local impregnations; but if the formation of the reefs took place after the date of the rhyolite outbursts, which seemed to be the author's contention, that was a novel idea that would require full discussion after the true nature of the rocks had been obtained by experts. Mr. McKay had done the most laborious part of the work in collecting ample material in a most thorough manner.

The Chairman thanked Mr. McKay for exhibiting these interesting specimens, and for his explanation as to their nature and the character of the geological district from which they were collected. If the hydrothermal action in the formation of gold was proved it would settle a most important question.

THIRD MEETING: *17th August, 1898.*

Mr. E. Tregear, President, in the chair.

New Member.—Mr. J. Singer.

Paper.—On "Volcanoes of the Pacific," by Coleman Phillips. (*Transactions*, p. 510.)

The Chairman, in inviting discussion, said the dates of the eruptions mentioned should be given before we could determine whether they were

connected with the movements in New Zealand. He did not see how the coral-reefs referred to could help us, in the manner suggested, to form our breakwaters.

Sir James Hector, in response to the President's request, said he was glad that the author had commenced the important work of collecting and placing on permanent record the changes now taking place in the Pacific Ocean. It was the largest area of the earth's surface covered by ocean, and volcanic forces were active in many parts of it, but whether they were sporadic or along defined lines due to structural features in the underlying earth's crust had yet to be determined. He was therefore glad that a start had been made by the author of the paper to collect the ephemeral records on the subject.

Mr. Haylock exhibited and described a large sea-worm found in Lowry Bay, and named by Professor Dendy *Echiurus novæ-zealandiæ*. The internal anatomy was given in the "Challenger" reports.

Sir James Hector said it was formerly placed among the star-fishes, but it was now in its proper place with the worms.

Sir James Hector exhibited and described the following specimens :—

1. Two large live specimens of the tuatara, *Hatteria (Sphenodon) punctata ;* also the eggs and young.

This species of reptile, it was stated, was one of the proofs of the evolutionary theory, it being the sole remnant of an ancient primordial organism, and uniting in one form characteristics of birds and reptiles. Attention was called to the pineal eye.

2. A specimen of crocodile (*Crocodilus americanus*).

3. The crayfish (*Palinurus edwardsii*), prepared to show the anatomy.

It was a good type study for students. Other specimens were exhibited and described, and the life-history given.

4. *Emmelichthys nitidus*, a rare fish, allied to the kahawai. One was previously obtained by Sir George Grey, and one by Mr. Travers.

5. Drake sent by Mr. Taylor White ; hybrid between New Zealand grey duck and mallard.

Fourth Meeting : *20th September, 1898.*

Mr. E. Tregear, President, in the chair.

Papers.—1. "The Fungus Flora of New Zealand," by George Massee, F.L.S., F.R.M.S.; communicated by Sir James Hector. (*Transactions*, p. 282.)

Sir James Hector explained the growth, nature, and composition of the ordinary edible mushroom and suchlike fungi, including, of course, toadstools, puff-balls, &c., which, he said, formed almost the very lowest grade in vegetable life. The extraordinary power of fungi to propagate

and spread the germs of fearful zymotic diseases was pointed out, and Mr. Massee, in his paper, stated that millions of pounds' worth of damage to crops of grain by rust and other affections could be traced to poisonous fungi. This loss might be easily prevented by experts imparting knowledge to those concerned. He considered the information contained in Professor Massee's paper to be most valuable.

The President thanked Sir James Hector for the interesting and instructive explanation he had given on this subject. He hoped other members would take the matter up and add to our information.

Mr. Travers, who had at one time collected this class of vegetable organisms, said he handed them to a visiting Swedish naturalist for his museum, and had not since heard of them. Among the English only one form of fungus (the mushroom) was eaten, but on the Continent, and in Russia particularly, many other forms which we looked upon with disgust were eaten, and found to be an extremely nutritious and valuable food. It was difficult to say what form of vegetable life was not attacked by the germs of disease propagated by different forms of fungi. Unquestionably this fungi study was a highly valuable one. It was interesting to know that this was only the first part of a paper which Professor Massee was contributing in sections to the New Zealand Institute.

Mr. Hudson said the fungus eaten was the yellow one, found under pine-trees.

Sir James Hector, in reply to Mr. Richardson, said it was no use to cut them to get rid of them, as they did not grow again.

2. "On the Interaction of Cyclones on one another," by Major-General Schaw, C.B., R.E. (*Transactions*, p. 567.)

Sir James Hector explained the system followed by his department in recording weather observations. He said that advices as to weather indications were received by him daily, not only from all parts of the colony, but from Australia, and even more distant parts. Until a short time ago these used to be sent out all over the colony through the Press Association, but for some reason or other the Association had discontinued this valuable practice. Sir James Hector expressed surprise, too, that the newspapers did not publish the weather chart daily. He thought that the subject treated by General Schaw was fully explained by the diagrams used in the Meteorological Office.

Mr. Harding said the newspapers in Australia and England paid a good deal of attention to these weather diagrams, and always used them.

3. "On the Use of Formaline," by Dr. G. Thilenius; communicated by Sir J. Hector. (*Transactions*, p. 101.)

The question was raised as to whether anything further had been heard of the kumi, the strange animal or reptile alleged to have been seen near Gisborne recently.

Sir James Hector said the word "kumi" appeared in Mr. E. Tregear's Maori-Polynesian dictionary, one of the definitions given being "a huge fabulous reptile."

Mr. Tregear told the members that, so far as his use of the word was concerned, he considered the animal mythical, but it did not follow that it was actually so. The only knowledge he had on the subject was that the early explorers were told by Maoris that there was a kind of big lizard, sometimes 5 ft. or 6 ft. long, which was eaten. That it should be eaten was rather surprising, considering the aversion, and even horror, with which the Maoris regarded lizards. If such a strange animal as was reported really existed, it would perhaps turn out to be a species of Australian iguana.

Sir James Hector considered this a geographical improbability. As to the alleged kumi, he said that in 1875 Mr. Carlton, then Chairman of Committees in the House of Representatives, and a great scholar, rushed into his (Sir James's) room with the remark, "At last we have really got it." It transpired that Mr. Carlton referred to a strange quadruped "with six legs" which had been found in a flooded river somewhere about Hokianga, and the natives, horrified at seeing such an extraordinary creature, hacked it all to pieces. If the kumi existed at all it might, he thought, be found allied to the great salamander of Japan, now almost extinct. The reported description indicated this; and it was certainly a reptile of this kind that was carved on a gable-post at Rotorua, and which was figured in Hochstetter's "New Zealand," p 424 (Eng. trans.).

Mr. Harding read extracts of letters from the Rev. Mr. Colenso on the subject.

Fifth Meeting: *18th October, 1898.*

Mr. E. Tregear, President, in the chair.

Major-General Schaw was nominated to vote in the election of Governors of the New Zealand Institute for the ensuing year.

The President drew attention to the death (18th October, 1898) of Mr. John Buchanan, F.L.S., a very old member of the Society.

Sir James Hector said Mr. Buchanan was well known to the members as one who had done great service to the New Zealand Institute by the beautiful way in which he had illustrated Volumes I. to XIX. of their Transactions. When he (Sir James) came out to New Zealand in 1861 Sir Joseph Hooker asked him to look out for a man called John Buchanan, who sent Home to the herbarium at Kew the best collections of plants that were received from Australasia. On arrival in New Zealand he (Sir James) accordingly advertised for Mr. Buchanan, who immediately responded, and to whom he was able to give an appointment as draughtsman and botanist in 1862. About six years ago Mr. Buchanan retired from the public service. Mr. Buchanan contributed many valuable papers—perhaps the most valuable papers that had ever been contributed—to the botany of New Zealand, and he also worked in the interests of science in many other ways. He was a great explorer, or, rather, wanderer, and he endured much hardship in collecting specimens of geological interest, minerals, birds even, and certainly, above all other things, plants. Mr. Buchanan's collection of plants made in New Zealand were forwarded from time to time to Sir Joseph Hooker at Kew, and the whole of the plants he collected up to 1863 were embodied in the "Flora of New Zealand," published in 1865. Of course, since then he had made other large collections. These also were sent to Kew; but duplicates remained here, and were placed at the disposal of the late Mr. Kirk, who had made use of them in his work, now partly published. Mr. Buchanan had left a large collection of specimens, books, drawings, and manuscript notes, all of which he (Sir James) saw on the last occasion on which he was in Dunedin in the crypts and cellars underneath the museum in that city. Sir James added that he hoped a little better care would be taken of the collection until they reached a more enlightened age. There might be many

unknown facts embodied in these notes, because Mr. Buchanan studied the botany of New Zealand at a time when there were no rabbits, and when there had been no great bush-fires—when the country was more in a state of nature than it was now. His botanical researches in the south of New Zealand were made single-handed; and the great interest of the botany of New Zealand lay in the original flora of the far south. Sir James repeated that he hoped great care would be taken to preserve every scrap of work left by Mr. Buchanan. They all mourned Mr. Buchanan's death, though at the same time it had to be said that it was a happy release for him.

Paper.—"On Seasonal Time," by G. V. Hudson, F.C.S. (*Transactions*, p. 577.)

Sir James Hector thought there were many practical difficulties in the way of putting Mr. Hudson's proposal into practice. He fancied, for instance, that it would be hard to get the boys up in the morning at 6 o'clock simply by calling the time 8 o'clock. There would also, he fancied, be some trouble in getting their domestic helpers to appreciate the change. School and other examinations were everywhere held before the holiday time of the year. The balances of New Zealand financial institutions had at the present time necessarily to correspond with the balances made by similar institutions in Great Britain.

Mr. E. Tregear welcomed the proposal, because he was in sympathy with any movement that would take them back to a more natural way of living. He pointed out that the best part of the day in Wellington in the summer months was the interval in the morning between sunrise and about 8 o'clock.

Mr. Hudson briefly replied.

The following additions to the Museum were exhibited by Sir James Hector:—

1. A collection of lizards, from Mr. Andrews, of Picton. This included a living specimen of *Naultinus sulphureus*, or sulphur lizard.

Sir James Hector said the specimen was almost unique. The first specimen secured was one which he obtained when he was travelling in the Rotorua district with Sir George Grey in 1866, and it had been described by Sir Walter Buller in the third volume of the "Transactions of the New Zealand Institute." Sir James also mentioned a collection of lizards made by Master Fitzgerald (son of Mr. W. C. Fitzgerald), which was also on exhibition. The collection had been arranged in jars in an interesting manner by Mr. Yuill. It probably included some species that were perfectly new. All the lizards had been obtained by Master Fitzgerald within a few miles of Wellington.

2. The golden pheasant (*Thaumalia picta*), from China.

Sir James Hector said, when alive this particular bird was an attractive feature in the grounds of the Acclimatisation Society at Masterton. Unfortunately, it came to an untimely end, and it was shrewdly suspected that its murderer was a weasel or some pest of that kind. Although the pheasant was somewhat mangled in its struggle for life, Mr. A. Yuill had set it up in splendid style.

3. Fish (*Scorpæna cruenta*, Sol.) caught at Wellington Heads by Master F. Alp; presented by Mr. W. Lambert.

4. *Anosia bolina* butterfly; presented by Mr. Andrews, of Picton.

5. Pearl oyster, seven months' growth, found on the bottom of an iron ship at Samoa.

6. Shells (*Crenella impacta*), Queen Charlotte Sound; presented by Miss Mestayer.

7. A *Megale* spider, with eggs.

An interesting point in connection with the kumi controversy was mentioned by Mr. E. Tregear.

He said that Mr. F. W. Christian had left behind him a great deal of work to be edited by the Polynesian Society. That day he was reading the proofs of the vocabulary of Nukuora, a little island in Micronesia. There was hardly a word in it that was not the purest Maori, and the islanders' word for lizard was "kumi."

Mr. R. C. Harding questioned whether the word might not have a particular meaning as opposed to a general meaning.

In reply, Mr. Tregear said the word was used in compound forms, so that it was evidently the general word for lizard.

SIXTH MEETING: *22nd November, 1898.*

Sir W. L. Buller in the chair.

New Members.—The Rev. Mr. Masters, Mr. M. C. Smith, and Mr. W. Welch.

A letter from Mr. Coubrough, sending a circular about ironsand, was read, and laid on the table.

The Chairman called attention to the death of the late Mr. Charles Hulke.

He said he was sure that every member would deplore the loss of so active a member of the Society. He was a former President, and always took a great interest in the proceedings. He had known Mr. Hulke personally for twenty years, and could speak of him as a thoroughly conscientious and honourable man. He was a perfect enthusiast in his profession—that of a teacher—and was well informed on almost every subject. He was an excellent analytical chemist, and did much useful practical work in that line. He was a good German linguist, and one of the earliest volumes of their Transactions contained, he believed, his translation of Dr. Otto Finsch's pamphlet, being a criticism of his (Sir W. Buller's) Essay on the Ornithology of New Zealand. Mr. Hulke's last appearance among them was at the conversazione held at the Museum in the early part of the session. He appeared then to be in perfect health, and he remembered him making some very original observations on the live tuataras exhibited on that occasion in the Maori House. By his death at a comparatively early age the Society had sustained a serious loss.

Papers.—1. "On the Ornithology of New Zealand," by Sir W. Buller. (*Transactions*, p. 1.)

2. "On *Anosia bolina*," a beautiful butterfly that has recently made its appearance in this district, by A. P. Buller; communicated by Sir W. Buller. (*Transactions*, p. 38.)

Mr. Hudson said this rare butterfly had now been found in Auckland, Nelson, and Collingwood.

3. "On the Shooting Stars in November, 1898," by Sir J. Hector.

Sir James Hector said the November shooting stars originated in the year 126, and were caused by a comet being drawn from its usual course by the attraction of Uranus, a stream of stars thus being formed about a million miles in width from side to side, about a hundred thousand miles in depth, 1,885,000,000 miles in length, and 4,400,000,000 miles in circumference. Through this immense ribbon of stars the earth passed once in every thirty-three years, and, as the stars were travelling the opposite way to the earth, and at a speed of about twenty-three miles per second, while the earth travelled at twenty-two miles per second, they passed at the rate of forty-five miles per second. In 1833 and 1866 there were magnificent displays of these shooting stars, but the appearance since the last display of what was thought to be the head of the comet gave promise of the shooting stars of next November being a more awe-inspiring sight than ever. The other day cablegrams from America announced that some of the shooting stars had been seen there. That was the advanced guard of next November's display. It took three days to go through the ribbon, but the intense portion only occupied six or seven hours in passing. Sir James could not see how we in New Zealand were to suffer from the shooting stars. We might see them, but they would pass at a tangent. Although they looked formidable, they were not to be regarded as a source of danger in any way. In the course of his remarks Sir James stated that about a hundred thousand meteors fell into our atmosphere nearly every week in the year, and they hardly ever reached the earth's surface. An occasional one did get down. There was one at the Museum here which fell at Masterton. It weighed only 9 lb., and consisted of aluminium, iron, nickel, and one or two of the basic ores. This was the only one as yet found in New Zealand. The resistance of the earth's atmosphere usually reduced them to dust before they reached the earth.

Sir James Hector exhibited a number of additions to the Museum, and made the following remarks on some of the specimens:—

The Olive.—The cultivation of the olive had not been attempted to any extent in this colony, but there appeared to be some inducement to undertake it. A specimen of the New Zealand olive, sent by the schoolmaster at the Upper Hutt, was produced, and evoked a short dissertation on olive-growing from Sir James Hector. If the olive proper was grafted on to the New Zealand olive, Sir James said, the trees would bear fruit in twelve months, or at the most two years, whereas the imported trees brought into the colony by Sir George Grey had taken from thirteen to seventeen years before they bore. Mr. Travers agreed with Sir James Hector, and thought the idea of grafting on to the local species a very good one.

Birds.—Among the birds exhibited were two cuckoos recently captured—one of them, in fact, was caught at Vogeltown. A peculiar feature about these specimens, Sir James Hector remarked, was the fact that both of them were gorged with young birds. It was well known, he said, that the cuckoo made use of the nests of other birds to deposit its eggs, but he did not think he had met a case before where the cuckoo had eaten the young occupants before making use of the nest.

The Slug.—Amateur gardeners who at this time of the year particularly bewailed the ravages of slugs would be surprised to learn that there was at least one species of slug which was a particular friend of the gardener. A specimen was exhibited which, to use the semi-jocular remark of Mr. Travers, was a "very useful beast indeed." It was a carnivorous slug, and fed on the blights which frequented tender plants, and which were very difficult to get rid of by other means without injuring the plants. Slugs of this sort would be a blessing to many sufferers from blight-pests.

Sir Walter Buller said he had listened with interest to Sir James Hector's account of the two specimens of kohoperoa on the table. Sir James Hector was wrong, however, in supposing that the predatory character of *Eudynamys taitensis* was a new discovery. Thirty years ago he had himself found in the stomach of one of these birds a small fledgling that had evidently been robbed from a nest. On another occasion he had surprised one of these cuckoos carrying off in its beak a tui's egg. He understood Sir James Hector to say that the bodies found in the stomachs of the two birds now on the table were those of the grey warbler—*Gerygone flaviventris*—nestlings with wing-feathers just sprouting. If so, this was very curious, because, as was well known, this little bird performed the duty of foster parent to both the kohoperoa and the shining cuckoo, two species belonging to very different genera. The warbler built a pretty pensile nest, with the entrance near the top, protected by a kind of porch. It would seem in this case that the predatory cuckoo had devoured the rightful occupants before appropriating the nest and depositing its egg. His impression was that the nestling which the stomach of his bird contained was a very young tui. At any rate, he was sure it was the young of a native bird, for at that time the country had not become overrun as now with the introduced species for which we had to thank the mistaken zeal of our acclimatisation societies.

Annual Meeting: *14th March, 1899.*

Sir W. L. Buller, Vice-president, in the chair.

Abstract of Annual Report.

The Council regret having to report the loss by death of no less than five valued members—viz.: the late Thomas Kirk, W. M. Maskell, John Buchanan, C. Hulke, and Rev. W. Colenso.

The balance-sheet showed that the receipts for the year, including the balance carried forward from last year, amount to £194 6s. 5d., and the expenditure to £95 4s. 9d., leaving a balance in hand of £99 1s. 8d., to which has to be added the sum of £33 9s. 8d. lodged in the bank at interest as a Research Fund, making a total balance of £132 11s. 4d.

Election of Officers for 1899:—*President*—E. Tregear; *Vice-presidents*—G. V. Hudson, Sir James Hector; *Council*—R. L. Mestayer, H. B. Kirk, G. Denton, M. Chapman, E. F. Hawthorne, Sir W. Buller, B. M. Molineaux; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

The Chairman drew attention to the loss the Society had sustained by the death of the late Rev. W. Colenso, and Sir James Hector moved, That a record be made in the minutes of the great services rendered by the deceased gentleman.

In doing so he said the deceased had been an intimate friend of his

for the last thirty-five years, and also a constant correspondent. As they all knew, Mr. Colenso had been a constant contributor to the work of the New Zealand Institute. He took a lively interest in its progress, and in its success in every direction. He contributed to its meetings articles of the greatest interest and value upon almost every branch of natural science. He did valuable work as an explorer in the early days of settlement in New Zealand, and then and subsequently he did good work as a recorder in zoological science. But above all things he did good work in extending their knowledge of the botany of New Zealand. No one who turned over the pages of Hooker's "Flora of New Zealand" could fail to see what a master mind his was, and what a master hand he had in collecting accurate knowledge in natural science. But these were by-paths in comparison with his great work in philology. When he came to New Zealand he was employed in printing the New Testament in the Maori language, and bound the work also with his own hands. A copy of this Testament, which he presented to Mr. R. C. Harding, one of their fellow-members, was on the table before them that night. The inscription in it stated that it was composed, printed, and bound by Mr. Colenso with his own hands, in the year 1837. However, that was not the end of his work. In addition to all his scientific labours, he carried on a very large and charitable work among the Maoris. But, above all, his mind was for many years almost solely devoted to the collection of the great treasures of knowledge that were buried in the languages of Polynesia, and particularly to the tracing out of the words that were involved in the Maori language. He was employed by the Government for many years to collect and arrange and prepare a lexicon of the Maori language and the cognate languages of Polynesia. He (Sir James) was, about 1870, asked to inspect the manuscript of this great work, and he was really surprised at its extent. It almost filled the walls of a room. And the manuscript, too, had been done in the most systematic manner. But, unfortunately, one or two of the important letters of the alphabet—they were very important; he thought they were "Ng" and some others—were at the time mislaid. The loss so disheartened Mr. Colenso that he seemed to have left off work for some time. There had been, he regretted to say, a few hard things said about Mr. Colenso for his apparent dilatoriness in getting on with the lexicon. But no one who knew of the exertion Mr. Colenso gave to the work could blame him in the least. There were many reasons at work, most of which were set forth in the small fragment of the lexicon that was published three years ago—half of the first letter. That fragment was enough to show what a great work the lexicon would have been if published under his eye. Mr. Colenso had presented this great work, under certain very moderate conditions, so he was informed, to the Government, for them to deal with it as they pleased. He presumed that what Mr. Colenso had stipulated was that the work should not be lost, but should be published for the public benefit. In making other donations Mr. Colenso had been most lavish. He had presented to the Theological Library of Napier the whole of his collection of theological works and his collection of scientific works. His most valuable collection of zoological, botanical, and mineral specimens he had presented to the Napier Museum. He had also made certain donations to the Colonial Museum in Wellington, and in aid of that institution. In every way he had displayed a most liberal mind, and left behind him an influence for good. He was the founder, with the late Sir George Grey, of the New Zealand Society, upon which the Wellington Philosophical Society was engrafted; and he was a yearly member of the latter Society.

Mr. R. C. Harding said it was thirty-eight years that month since he first met the late Mr. Colenso. During the whole of that time he knew

Mr. Colenso very intimately indeed, and during the whole of his (Mr. Harding's) residence in Wellington—nearly nine years—he had been in very close and intimate correspondence with him. He could fully indorse what Sir James Hector had said about Mr. Colenso's enormous industry and great gifts. He believed that every volume of the "Transactions of the New Zealand Institute" had contained valuable contributions from the hand of Mr. Colenso. In the first volume would be found two papers contributed by him by special request. One was on the aboriginal natives and the other was on the botany of New Zealand. These papers, he might say, would in themselves be sufficient to make the reputation of a scientific man for industrious investigation and scientific knowledge. In regard to the New Testament printed by Mr. Colenso, he (Mr. Harding), as a practical printer, thought it was one of the most wonderful productions that had ever issued from a printing press, when they considered the imperfect outfit with which Mr. Colenso was provided. And he believed that Mr. Colenso learned the art of bookbinding before he left London, in order that he might complete the works which he printed. When Mr. Colenso's book "Fifty Years ago in New Zealand" reached England Mr. William Blades, author of the "Life of Caxton," wrote an article on it for the Printers' Register under the title of "A New Zealand Caxton." As to the Maori Lexicon, Mr. Colenso did not look upon it as completed, because he had not written a fair copy of the manuscript. But his rough manuscript was as good as most of the fair copy that passed into a printer's hands. Mr. Harding concluded by expressing the hope that the Government would be public-spirited enough to put the work of printing the lexicon in hand, and so prevent the loss of the life-work of one of the greatest men they had had in New Zealand.

Mr. W. T. L. Travers spoke of the enormous diligence shown by Mr. Colenso in his investigation of the natural history of the colony.

Sir James Hector said Mr. Colenso had a great controversy with the late Sir Richard Owen as to whether or not he was the first European discoverer of the moa as part of the fauna of New Zealand. Mr. Colenso claimed that he was the first person to bring before the notice of Europeans the recent existence of these great birds in New Zealand as part of the fauna of the country. It was on that account that his name was received with such great favour at Home when he was elected a Fellow of the Royal Society of London. The controversy ended in its being shown that Mr. Colenso appreciated the nature of the gigantic bones of birds that had been discovered here before they were sent to England.

Sir Walter Buller said he visited Mr. Colenso in 1886 before he (Sir Walter) went to England. Mr. Colenso did not then mention the loss of any part of the manuscript of the lexicon. He (Sir Walter) thought the missing letters must have been recovered, because there were no empty pigeon-holes at that time in the room in which the manuscript was kept. Sir Walter went on to mention a letter he had received from Sir Joseph Hooker, in which the writer spoke of Mr. Colenso as doing good sound work in philology—work that would live.

Papers.—1. "On New Zealand *Galaxidæ*," by F. E. Clarke. (*Transactions*, p. 78.)

2. "On *Exocœtus ilma*," by F. E. Clarke. (*Transactions*, p. 92.)

3. "On *Girella multilineatus* (the Mangrove Fish)," by F. E. Clarke. (*Transactions*, p. 96.)

4. "On Artesian Wells at Longburn," by J. Marchbanks; communicated by Sir J. Hector. (*Transactions*, p. 551.)

Sir James Hector described with drawings the geological structure of this district, and explained how the water had been obtained. He said it was a matter of enormous importance to a district like this, and a subject of congratulation to the Manawatu Railway Company, that it should have an underground supply of water of such an ample nature. It was not only water that came to the surface, but water with power. He complimented Mr. Marchbanks upon the manner in which he had treated the subject before the meeting, and for his having successfully carried out the work.

5. On "Further Light on the Circulation of the Atmosphere in the Southern Hemisphere," by Major-General Schaw. (*Transactions*, p. 570.)

6. "Moa Farmers," by Richard Henry; communicated by Sir James Hector. (*Transactions*, p. 673.)

7. "Old Huts at Dusky Sound," by R. Henry; communicated by Sir James Hector. (*Transactions*, p. 677.)

8. Red Cats and Disease," by R. Henry; communicated by Sir James Hector. (*Transactions*, p. 680.)

Mr. Harding showed a perfect copy of the New Testament in Maori, printed and bound by the late Rev. W. Colenso; also the first card printed on in New Zealand.

A collection of sponges from the Chatham Islands was exhibited by Captain Cooper.

Mr. McLeod showed some human bones and stone implements found by him at Karaka Bay (Miramar).

Mr. G. V. Hudson laid before the meeting a set of beautiful plain and coloured plates to illustrate his forthcoming work on New Zealand moths and butterflies.

AUCKLAND INSTITUTE.

First Meeting: *30th May, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

New Members.—E. Hall, F. W. Hilgendorf, J. M. Maclaren, W. A. MacLeod, Dr. R. H. Makgill, A. P. Wilson.

The President delivered his inaugural address, taking as his subject "Auckland City, Past, Present, and to come."

Second Meeting: *20th June, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

New Member.—J. S. Kidd.

Papers.—1. "On the Habits of *Dermestes vulpinus,*" by A. T. Potter. (*Transactions*, p. 104.)

2. "On some Occurrences of Gold in the Coromandel District," by J. M. Maclaren. (*Transactions*, p. 492.)

3. "Notes on the Volcanoes of the Taupo District," by Dr. Benedict Friedlaender; communicated by T. F. Cheeseman, F.L.S. (*Transactions*, p. 498.)

Third Meeting: *4th July, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

Mr. W. J. Morrell, M.A., gave a popular lecture on "The Aims of Education."

Fourth Meeting: *25th July, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

Dr. J. S. Maclaurin gave a popular lecture, illustrated by numerous experiments, on "Gold: Its Occurrence and Extraction."

Fifth Meeting: *15th August, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

New Members.—A. Busck, Dr. Pabst.

Papers.—1. "On the Occurrence of the Australian Snipe (*Gallinago australis*) in New Zealand," by T. F. Cheeseman. (*Transactions*, p. 105.)

2. "On a West Coast Dolerite, and on a Hypersthene-andesite from White Island," by W. A. MacLeod, B.Sc. (*Transactions*, pp. 487 and 488.)

3. "A Contribution to the Study of the Rotifers of New Zealand," by F. W. Hilgendorf, M.A. (*Transactions*, p. 107.)

4. "The Future of the New Zealand Bush," by the Rev. Canon Walsh. (*Transactions*, p. 471.)

Sixth Meeting: *29th August, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

The Most Rev. the Primate of New Zealand (Dr. Cowie) gave a popular address entitled "Reminiscences of Forty-five Years."

Seventh Meeting: *19th September, 1898.*

Professor Talbot-Tubbs, President, in the chair.

Mr. T. F. Cheeseman, F.L.S., gave a popular lecture, copiously illustrated with lime-light views, on "The Mount Cook District."

Eighth Meeting: *10th October, 1898.*

Professor Talbot-Tubbs, President, in the chair.

New Member.—W. B. Brain.

Papers.—1. "On a New Species of *Corysanthes*," by T. F. Cheeseman. (*Transactions*, p. 351.)

2. "On the Occurrence of *Ottelia* in New Zealand," by T. F. Cheeseman. (*Transactions*, p. 350.)

3. "Botanical Notes," by D. Petrie, F.L.S. (*Transactions*, p. 352.)

4. "On a Hornblende Trachyte from Coromandel," by W. A. MacLeod. (*Transactions*, p. 490.)

5. "The Geology of Moehau Mountain, Cape Colville," by J. M. Maclaren. (*Transactions*, p. 494.)

6. "On the Shells of Whangarei Heads," by C. Cooper. (*Transactions*, p. 134.)

7. "On the Birds of the Bay of Islands," by A. T. Pycroft. (*Transactions*, p. 141.)

8. "The Art of Weaving among the Maoris," by Elsdon Best. (*Transactions*, p. 625.)

9. "Social Parasites," by E. A. Mackechnie.

NINTH MEETING: *31st October, 1898.*

Professor H. A. Talbot-Tubbs, President, in the chair.

The Rev. Mr. Beatty gave a popular lecture on "Ruskin: His Life and Writings."

ANNUAL MEETING: *27th February, 1899.*

Professor H. A. Talbot-Tubbs, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

The number of members on the roll at the present time is 163, of whom eleven are life-members and 152 annual subscribers. Ten new members have been elected during the year; but, on the other hand, fourteen names have been removed—three from death, eight from resignation, and three from non-payment of subscription for more than two consecutive years.

It is the painful duty of the Council to draw attention to the names removed from the roll by death.

Mr. T. Kirk, whose decease occurred immediately after the last annual meeting, was one of the original members and founders of the society, and was its first secretary and curator. His attainments as a botanist are widely known, and every volume of the Transactions, since its first appearance in 1869, contains numerous contributions from his pen, many of them being of considerable scientific importance. It is greatly to be regretted that he did not live to complete the general work on the flora of New Zealand upon which he was engaged; and, in any case, his removal from the small band of scientific workers in New Zealand is much to be lamented.

Mr. F. D. Fenton was also one of the founders of the society. Although he invariably refused to serve on the Council, there are few members who have taken more interest in the working of the Institute, or have given more practical assistance towards securing its progress. During the formation of the collection illustrating the manners and customs of the Maori race, now exhibited in the Ethnological Hall, his co-operation was invaluable. He not only presented a large number of articles, and assisted in procuring others, but his wide knowledge of everything appertaining to the Maori was always freely placed at the service of the curator.

The following brief synopsis of the balance-sheets appended to the report will make the financial position of the society fully intelligible.

The total revenue of the working account, excluding the balance of £139 14s. 11d. brought from the previous year, has been £899 2s. 10d. Last year the amount was £1,176 7s. 6d., so that there has been a decrease of £277 4s. 8d. This is due to two causes: first, the almost total cessation of mining on the Waikanae Block, and the consequent extinguishment of all income from it; and, second, to the fall in the rate of interest, which has compelled the Council to renew several of their investments on much less satisfactory terms. Examining the separate items in the balance-sheet, it will be noted that the receipts from the invested funds of the Costley bequest stand at £365 16s. 3d., as against £413 0s. 4d. for 1897–98; the Museum endowment has yielded £355, the amount for the previous year being £619 15s. 11d.; while the sum received from members' subscriptions is almost the same as that credited last year. The total expenditure has been £954 13s., leaving a balance of £84 4s. 9d. in the Bank of New Zealand. The Council are glad to state that the invested funds of the Institute are in a satisfactory state. The total amount is now £13,590, showing an increase of £310 during the year. With the exception of a few hundred pounds, the whole of this sum is invested in mortgages on freehold security; and there is every reason to believe that the securities are exceptionally good and stable.

Election of Officers for 1899.—*President*—J. Batger; *Vice-presidents*—Professor H. A. Talbot-Tubbs, E. Roberton, M.D.; *Council*—G. Aickin, W. Berry, C. Cooper, F. G. Ewington, E. A. Mackechnie, P. Marshall, F.G.S., T. L. Murray, T. Peacock, D. Petrie, F.L.S., J. A. Pond, F.C.S., J. Stewart, C.E.; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *4th May, 1898.*

Dr. W. P. Evans, President, in the chair.

New Members.—Mr. W. H. Hammond, Miss L. Stevenson, Miss E. Kitchingman.

The following resolution was passed: "The Philosophical Institute of Canterbury hereby places on record its regret at the death of its late member, Mr. W. M. Maskell, and its appreciation of his services in the cause of science, especially in entomology, and requests the President to convey to Mrs. Maskell its sympathy with her in her sorrow."

Papers.—1. "An Instrument for roughly determining the Relative Thermal Conductivities of Liquids," by Dr. W. P. Evans. (*Transactions*, p. 555.)

Dr. W. P. Evans exhibited a model in illustration of his paper.

2. "On the Burning and Reproduction of Subalpine Scrub and its Associated Plants, with Special Reference to the Arthur's Pass District," by Mr. L. Cockayne. (*Transactions*, p. 398.)

Mr. L. Cockayne exhibited botanical specimens and photographs in illustration of his paper.

Professor Dendy exhibited a large specimen of *Raoulia mammillaris* (the vegetable sheep), lately obtained from Mount Torlesse, and drew attention to its peculiar scent, somewhat resembling that of a lemon-scented verbena.

Professor Dendy exhibited a number of specimens of New Zealand lizards, including *Lygosoma grande* and *Naultinus elegans* (with newly born young), from the South Island, and *Naultinus grayi*, from the North Island, and pointed out that the latter is probably specifically distinct from *N. elegans*.

Dr. Evans exhibited new chemical apparatus.

Captain Hutton exhibited and made remarks upon a moa-bone obtained from the silt at St. Martins, Port Hills, and presented to the Museum by Mr. R. M. Laing.

Second Meeting: *1st June, 1898.*

Dr. W. P. Evans, President, in the chair.

Address.—Professor Bickerton delivered an address on "Some Recent Advances in Experimental Science," illustrated by numerous experiments.

Captain Hutton exhibited some fragments of prehistoric pottery from Japan, and a volcanic bomb supposed to have been ejected from Mount Herbert.

Professor Dendy exhibited the specimen of *Naultinus grayi*, from the North Island, already shown at the last meeting, together with two young of the same animal, born about the 27th May. The young were compared with those of *Naultinus elegans*, from the South Island, and shown to be quite different, being without the characteristic pattern of the latter,* and of a bright yellowish-green tint (almost uniform) on the dorsal surface, and very much paler beneath.

Third Meeting: *6th July, 1898.*

Dr. W. P. Evans, President, in the chair.

Address.—Mr. R. M. Laing delivered an address on "Hypnotism: Its Fallacies and Facts."

Fourth Meeting: *3rd August, 1898.*

Dr. W. P. Evans, President, in the chair.

Address.—Mr. L. Cockayne delivered an address on "The Cultivation of New Zealand Alpine Plants," largely illustrated by specimens and lantern slides.

Papers.—1. "On the Genus *Weissia*," by Mr. R. Brown. (*Transactions*, p. 437.)

2. "Corrections in the Names of some New Zealand Rocks," by Captain Hutton. (*Transactions*, p. 483.)

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* The diamond pattern is already well developed in the newly born of *N. elegans*.

3. "Supplement to the *Stenopelmatidæ* of New Zealand," by Captain Hutton. (*Transactions*, p. 40.)

Fifth Meeting: *7th September, 1898.*

Mr. L. Cockayne, Vice-president, in the chair.

Mr. J. B. Mayne delivered an address on "The Cell," illustrated by numerous diagrams.

Paper.—"An Inquiry into the Seedling Forms of New Zealand Phanerogams and their Development. Part I: Introduction." (*Transactions*, p. 354.)

Mr. Cockayne exhibited the seedling and adult forms of *Veronica armstrongii.*

The Hon. Secretary exhibited a collection of scale-insects, belonging to the society, which was made and presented to the society by the late Mr. Maskell some years ago, and suggested that it might be desirable to present them to the Canterbury Museum. The matter was referred to the Council.*

Sixth Meeting: *5th October, 1898.*

Dr. W. P. Evans, President, in the chair.

New Member.—Professor R. J. Scott.

Mr. Dominick Brown moved, "That the President and Council be asked whether anything can be done by the Institute to promote antarctic exploration.

The motion was carried after a short discussion.†

Paper.—"On a Supposed Rib of the Kumi or Ngarara," by Captain F. W. Hutton, F.R.S. (*Transactions*, p. 485.)

Captain F. W. Hutton, F.R.S., exhibited and made remarks upon an albino skylark.

* At a subsequent Council meeting it was resolved that all the late Mr. Maskell's collections in the possession of the Institute be presented to the Canterbury Museum.

† At a subsequent Council meeting it was decided that it was unnecessary to take any action.

SEVENTH MEETING: *2nd November, 1898.*

Dr. W. P. Evans, President, in the chair.

New Members. — Mr. William Reece and Mr. R. D. Thomas.

Address.—Mr. R. Speight delivered an address on "The Microscope in Geology," illustrated by lantern slides.

The lecturer exhibited microscopic preparations of rock-sections in illustration of his address.

Papers.—1. "On the New Zealand *Musci*," by Mr. R. Brown. (*Transactions*, p. 442.)

2. "Some Recent Additions to the New Zealand Moss-Flora," by Mr. T. W. Naylor Beckett. (*Transactions*, p. 426.)

3. "Revision of the New Zealand *Pleurotomidæ*," by Mr. H. Suter. (*Transactions*, p. 64.)

4. "New Zealand *Polyplacophora*," by Mr. H. Suter. (*Transactions*, p. 59.)

5. "A Graphic Method of calculating Cubic Content of Excavation, as for Water-races on Uneven Ground," by Mr. G. Hogben. (*Transactions*, p. 602.)

6. "The Wanganui Earthquake of the 8th December, 1897," by Mr. G. Hogben. (*Transactions*, p. 583.)

7. The Tasmanian Earthquake," by G. Hogben, M.A. (*Transactions* p. 594.)

8. "Revision of the New Zealand *Phasmidæ*," by Captain F. W. Hutton. (*Transactions*, p. 50.)

9. "Notes on the New Zealand *Acrididæ*," by Captain F. W. Hutton. (*Transactions*, p. 44.)

10. "On the Footprint of a Kiwi-like Bird from Manaroa," by Captain F. W. Hutton. (*Transactions*, p. 486.)

The author exhibited the fossil footprint.

11. "Distillation Products of Blackball Coal: Part IV.," by Dr. W. P. Evans. (*Transactions*, p. 556.)

12. "Analyses of Seventeen New Zealand Coals," by Dr. W. P. Evans. (*Transactions*, p. 564.)

13. "Contact Metamorphosis at the New Brockley Coal-mine," by Dr. W. P. Evans. (*Transactions*, p. 557.)

The author exhibited specimens from the Brockley Coal-mine.

14. "On Occlusion of Sulphuretted Hydrogen in Coal," by Dr. W. P. Evans. (*Transactions*, p. 566.)

Eighth Meeting: *22nd February, 1899.*

Dr. W. P. Evans, President, in the chair.

The following resolution was passed: "The Philosophical Institute of Canterbury wishes to place on record its sense of the great loss science in New Zealand has sustained by the death of the Rev W. Colenso, who for so many years has done good work in philology, botany, and zoology."

Address.—Professor Dendy delivered an address on "The Life-history of the Tuatara," illustrated by diagrams and specimens. (*Transactions*, p. 249.)

Papers.—1. "On the *Neuroptera* of New Zealand," by Captain Hutton. (*Transactions*, p. 208.)

2. "On the Seedling Forms of New Zealand Phanerogams: Part II.," by Mr. L. Cockayne. (*Transactions*, p. 361.)

3. "On *Ligusticum trifoliatum*," by Mr. L. Cockayne. (*Transactions*, p. 424.)

4. "Descriptions of New Species of *Astelia, Veronica,* and *Celmisia*," by Mr. L. Cockayne. (*Transactions*, p. 419.)

5. "List of New Zealand Mollusca described in Foreign Publications since 1890," by Mr. H. Suter. (*Transactions*, p. 255.)

Annual Meeting: *5th April, 1899.*

Dr. W. P. Evans, President, in the chair.

New Members.—Mr. J. S. S. Cooper and Professor Arnold Wall, M.A.

Abstract of Annual Report for 1898.

Since the last annual meeting eight ordinary meetings have been held, and an extra meeting. At these meetings twenty-five papers have been read, as follows: Botany, 8; zoology, 7; geology, 5; chemistry, 3; physics, 2.

At six of these ordinary meetings special addresses of a more or less popular character have been delivered—viz.: "On some Recent Advances in Experimental Science," by Professor Bickerton; "On Hypnotism: Its Fallacies and Facts," by Mr. R. M. Laing; "On the Cultivation of New Zealand Alpine Plants," by Mr. L. Cockayne; "On the Cell," by Mr. J. B. Mayne; "On the Microscope in Geology," by Mr. R. Speight; "On the Life-history of the Tuatara," by Professor Dendy.

The attendance at the ordinary meetings has averaged 32·1, so that it will be seen that both in the number of papers read and in the average attendance there has again been an increase on the preceding year.

In addition to the ordinary meetings, a special meeting was held on the 21st September, in the Chemistry Lecture Theatre, when Captain

Hutton delivered a popular lecture on "The New Darwinism," which was well attended, and very highly appreciated by the public. A special general meeting was held on the 6th July for the purpose of making a slight alteration in Law VII.

The Council has met nine times since the last annual meeting, and amongst the business transacted the following items may be mentioned: The laws and rules of the Institute have been revised and reprinted; the old rule, No. XI., concerning the photographic section, which has ceased to exist, has been omitted.

A resolution urging upon the Government the desirability of protecting the eggs as well as the adult animals of the tuatara has been forwarded to the Colonial Secretary and complied with.

All the collections presented by the late Mr. W. Maskell to this Institute have been presented to the Canterbury Museum.

The Hon. C. C. Bowen was nominated to vote in the election of Governors of the New Zealand Institute.

The number of members of the Philosophical Institute of Canterbury at the present moment is seventy-five, as compared with seventy-seven in the preceding year.

The balance-sheet shows that the total receipts for the year have been £60 2s. 6d., and the expenditure £63 19s. 10d., which, with the balance carried forward from last year, leaves a balance in the bank of £17 19s. 11d. The sum of £50 0s. 7d. has been spent upon books and binding.

Additions to the library by donation and purchase have tak n place as usual. Captain Hutton has succeeded Dr. Evans as honorary librarian, and has generously presented the Institute with a set of "Natural Science" complete up to date.

It is deeply to be regretted that since the last annual meeting this Institute has twice been called upon to pass resolutions of regret and condolence—viz., on the occasions of the deaths of Mr. W. M. Maskell and the Rev. W. Colenso, while the Philosophical Society of Canterbury in particular has lost a most valued member by the death of Mr. C. R. Blackiston, its late honorary auditor.

The arrangement of a programme for the ensuing year, to be submitted to the incoming Council, has been left in the hands of the honorary secretary, who has much pleasure in announcing that Professor Arnold Wall, M.A., has kindly consented to deliver a popular lecture during the year, and Mr. J. S. S. Cooper an address on "Wireless Telegraphy." Other arrangements will be announced in due course.

Election of Officers for 1899.—*President*—L. Cockayne; *Vice-presidents*—R. Speight, Dr. W. H. Symes; *Hon. Secretary*—Professor A. Dendy; *Hon. Treasurer*—Captain F. W. Hutton; *Council*—Dr. Evans, H. R. Webb, R. M. Laing, T. W. Naylor Beckett, J. B. Mayne, and Professor Arnold Wall; *Hon. Auditor*—R. C. Bishop.

Presidential Address.—The retiring President, Dr. W. P. Evans, delivered an address on "Electricity in the Service of Technical Chemistry."

OTAGO INSTITUTE.

First Meeting: *9th May, 1898.*

F. R. Chapman, President, in the chair.

New Members.—Mr. W. Moore, of Waikouaiti; Mr. Stanley Carr, Dunedin; Dr. Frank Hay.

The President, in his opening remarks, stated that a message of sympathy had been sent on behalf of the Institute to Mrs. Kirk, together with the following resolution: "That the Council of the Otago Institute records its deep sense of the loss sustained by the colony in the death of the late Thomas Kirk, F.L.S., whose scientific labours have contributed so largely to the advancement of the study of botany in New Zealand."

Dr. T. M. Hocken read a paper on "The Fire Ceremony of the Fijians." (*Transactions*, p. 667.)

Second Meeting: *14th June, 1898.*

Dr. T. M. Hocken in the chair.

New Member.—Professor W. Blaxland Benham, D.Sc.

Paper.—"On some Peculiar Attachment-discs developed in some Species of *Loranthus*," by G. M. Thomson, F.L.S.

Abstract.

The author described the various forms of parasitic flowering-plants which were to be found in New Zealand, dwelling especially on the dodders (*Cuscuta*) and the various species of mistletoe (*Loranthus*, *Tupeia*, and *Viscum*). The dodders belong to the Convolvulus family. The seed falls into the ground and germinates there in the usual manner, putting out a delicate thread-like shoot. When this comes in contact with any part of a neighbouring plant it at once coils itself round it, and developes wart-like suckers, by means of which it abstracts nourishment from its host. These suckers send out minute root-like processes, which penetrate the tissues of the host, but this penetration, as a rule, does not extend much deeper than the cortex, so that the material abstracted consists of the already assimilated juices of the plant, and the parasite is therefore spared the necessity of producing leaves. As soon as the suckers develope the primary root dies. The mature dodder is then

a leafless parasite, consisting of thin reddish thread-like stems with pretty little pink flowers.

The seeds of mistletoe, on the other hand, are quite incapable of growing in the soil. They are eaten by birds, and pass undigested through their alimentary canal. If they are dropped on a tree they germinate in due course, and the radicle attaches itself to the bark like a little cushion, from the centre of which a conical mass of cells penetrates the tissues of the host as far as the wood-cells. Round this central cone the host-plant each year builds a rampart of new wood-cells, so that the mistletoe becomes, as it were, naturally grafted into the host. Its sucker, being in contact with the core of the plant, absorbs the unassimilated sap of the latter, and therefore the mistletoe has to do its own digestive work, and developes green leaves for the purpose.

The specimens referred to in the paper belonged to the yellow mistletoe (*Loranthus flavidus*), and were parasitic on the white birch (*Fagus solandri*); they were found at Lake Wakatipu by Miss Marchant. The mistletoe, instead of having one point of attachment, as is commonly supposed to be the case, was attached along the stem of the host-plant like a large dodder by means of numerous cushion-like discs, but these sent no suckers through the bark, and seemed to serve mainly as clasping organs. A somewhat similar instance is described and figured by Chatin ("Anatomie Comparée des Vegetaux"), of a species of Brazilian *Loranthus* parasitic on a *Citrus*, but in this case the clasping discs developed piercing suckers.

Specimens of *Loranthus* and *Tupeia* from the Town Belt were also exhibited.

Mr. G. M. Thomson also drew attention to the numerous forms of Fungi to be found at the present season of the year, and exhibited several species.

One of these, *Aseroe rubra*, developes underground like a small potato, and when mature it bursts from its coat and stands up from the soil like a crimson star-fish with five to eight radiating arms. The centre is filled with a gelatinous mass containing innumerable minute spores, and the whole has a most offensive smell, like putrid carrion. It appears to be very attractive to flies, which light on its disc, and must almost inevitably carry off and thus distribute the spores.

Another interesting species shown, of which great numbers appear every winter on the bank in front of the Middle District School, in Arthur Street, is a large toadstool belonging to the genus *Boletus*, one of the *Polyporeæ*. This toadstool is, like so many others of the family, very excellent eating, and appears at a time when mushrooms are difficult to obtain.

Mr. Hamilton laid on the table a copy of a list of the described genera and species of New Zealand Flowering-plants, arranged in alphabetical order, and gave a description of the plan on which the list had been compiled.

Dr. T. M. Hocken exhibited a photograph of a curious nest found in an almost inaccessible position on the Rock and Pillar Range, and described its unusual construction.

No one present was able to make any suggestion as to the kind of bird the nest was made by. It was suggested, however, that possibly it might be an old nest of the great extinct eagle (*Harpagornis*).

THIRD MEETING: *17th July, 1898.*

Mr. A. Bathgate, Vice-president, in the chair.

New Members.—Colonel Morris, Regent Road; H. J. Matthews, Mornington.

Copies of the Proceedings of the Institute for the last session were handed round for distribution.

Dr. Benham exhibited some specimens recently added to the Museum, and briefly described their most interesting points. The specimens included some rare Batrachians, and male and female specimens of a large crab from the New Hebrides.

FOURTH MEETING: *9th August, 1898.*

Dr. T. M. Hocken in the chair.

Professor Benham announced that he had just received a telegram from Dr. Young, of Invercargill, informing him that a fine specimen of the *Notornis* had just been caught by Mr. Ross on the west side of Lake Te Anau.

Professor Benham exhibited some specimens recently received at the Museum, the principal being the greater part of the eggshell of a moa, deposited in the Museum by Mr. Turton. This specimen was found in sandy soil near Clyde, Central Otago. Another specimen was found with it, but was accidentally destroyed.

Dr. T. M. Hocken communicated a paper on "Relics of the Old Native Population on the Upper Molyneux," prefacing it by some particulars as to the migration of the natives in the early times.

The writer of the paper described several old encampments of the natives on the line of the Clyde–Alexandra Road, and the stone knives, fragments of bones, and gun-flints found there.

Dr. Hocken then exhibited a number of rare and curious Maori weapons and implements, and described their use, and gave the history of the rarer specimens.

Mr. J. S. Tennant exhibited specimens of the nitrogenous nodules found on the roots of leguminous plants. The specimens were of unusual size, and were on the roots of lupins growing at the Ocean-beach Sandhills.

It was pointed out that the plant was very beneficial to sandhills, not only by fixing the sand, but at the same time enriching the soil through the bacterial action in the root nodules.

Mr. Hamilton exhibited a beautiful feather mat, made of feathers of the brown kiwi from the Kaimanawa Ranges, by Maoris at Opepe, near Taupo.

The mat was made more attractive by four strips, the whole length of the mat, about 4 in. wide, being of pure-white kiwi-feathers. The mat was kindly lent for exhibition by Mrs. H. Matthews. As this fine mat has only recently been completed it is evident that the art has not yet died out. It also shows that the North Island kiwi is still plentiful in certain districts, and that albino forms are not rare.

FIFTH MEETING: *13th September, 1898.*

A. Bathgate, Vice-president, in the chair.

New Member.—E. A. Petherick, London.

The Chairman mentioned that the third part of Mr. Hamilton's book on "Maori Art" had been published, and was now available for members and the public generally. All members of the Institute had the privilege of acquiring this handsome and valuable work at a reduced rate. The way in which the volume had been turned out by the publishers was a credit to the colony.

Papers.—1. "Notes on certain of the Viscera of the *Notornis*," by Professor W. B. Benham, D.Sc. (*Transactions*, p. 151.)

2. "Notes on the Fourth Skin of *Notornis*," by Professor W. B. Benham, D.Sc. (*Transactions*, p. 146.)

3. A. Hamilton: "On the Distribution of *Notornis*, and General Notes on the Genus."

ABSTRACT.

Mr. A. Hamilton read an interesting paper, stating the facts, so far as they were known, of the distribution of *Notornis*, of its relationship, its habits, and what had been already written and recorded about it. Now that *Notornis* had been proved still to exist, he asked if it would not be advisable for the authorities to organize a search expedition. It was a question whether the takahe should not be scheduled with the other protected birds. In the discussion which took place in the House of Representatives some days ago the question was raised of its being made compulsory for the more valuable specimens of native birds and specimens of native work being offered to the Government before being sent out of the colony. Before, however, such an Act could be made operative the State would have to recognise the claims of a Colonial Museum to a greater measure of support, and be prepared to purchase, under competent scientific direction, specimens which might be submitted. A long list of treasures might have been saved for the colony had such a museum been in existence hitherto. Was it too late? The suggested Act would not propose to stop business transactions of this kind; it would simply say that a declaration must be made of the specimen offered for sale, and the price it was valued at. This declaration would be submitted to the Government authority, and if it was thought desirable to retain the specimen the owner would be advised that negotiations could be opened for the purchase by the Government.

The Chairman observed that shortly after the account of the capture of the *Notornis* appeared in the papers an old Maori client of his from

Waitaki was in his office. He asked him if he had been down to the Museum to see the takahe. The Maori said he had not heard of its having been got, but he had seen one long ago. He described it as a bird like the pukeko, but not so long in the legs and neck, and was bigger, and said it lived in holes under trees in the bush, like the kakapo, but went erect into the holes. He had, he said, seen only one dead one, and that was at Aparima over fifty years ago, when the local natives told him there were plenty between Preservation Inlet and the Waiau, and that they went in patches. On the map the old Maori indicated, the locality referred to as between Lake Hauroto and Preservation Inlet. That portion of the country was probably less explored than any other part of New Zealand, so that if there were any adventurous spirits who wanted to go out and hunt the takahe there was a field for them.

Mr. G. M. Thomson hoped no one would be led into looking for the takahe in the country the Chairman referred to. There was a very limited extent of country; the ground was not high, and it was not more suitable than other places. He had been over the ground, and it had been run over by sheep some years ago. It was known to shepherds sixteen years ago.

Mr. Wilson had listened to what had been said with the greatest possible interest. It seemed to him that a most practical suggestion had been made by Mr. Hamilton – that was, to preserve the life of those birds. The thing that impressed him most was this fact: that this particular bird was not old. Some one mentioned to him that four years was about its age. He did not really know whether it was younger or older than that. The point was that within quite a year or two ago this creature must have been breeding in the mountains; and it was very probable that there was a considerable number of them there still. With the introduction of vermin, such as weasels and stoats, he thought the life of the bird could not be prolonged very much; and if any effort could be made to secure living specimens, and place them on the island that had been set aside for birds, he thought it would be a boon to the whole scientific world. It appeared to him that this was not likely to be done by those going out on camping expeditions. The bird could only be got in winter, when it was driven down from the higher to the lower lands; and that was the time that proper expeditions should be sent out to beat the whole country; and he had no doubt that good results would ensue. He would like to ask Dr. Benham what the specimen exhibited had in its gizzard.

Dr. Benham said the bird's gizzard contained a large quantity of small stones and some cylindrical kind of grass cut up into pieces from ½ in. to ⅝ in. in length. He had preserved some of the grass, and would be glad to hand it over to a botanist to make out what kind of grass it was.

Sixth Meeting: *18th October, 1898.*

Dr. T. M. Hocken in the chair.

New Member.—Dr. Fulton, Dunedin.

Papers.—1. "On the Study of Natural History," by G. M. Thomson.

Abstract.

One of the objects for which this Institute exists is to promote the study of natural history, by which I take it is meant not the merely biological side of the question, but the wider aspect, which includes all

natural phenomena. How best to accomplish this object is a matter worthy of consideration, and your Council has this evening adopted a small scheme which aims in this direction. It is proposed to offer prizes in our primary schools for the best set of natural history observations kept for a consecutive period by the pupils. These observations, recorded in the form of a note-book or diary, would deal with such phenomena as came under the direct observation of the young people. Daily notes of the weather; the direction and amount of the wind; dates of leafing, flowering, and fruiting of plants; appearance of birds, with notes on their song, their nests and eggs and habits; observations on the insects and other animals met with—these would form the staple subject for such a record. In the case of those whose parents were in a position to keep such instruments, daily readings of the barometer and thermometer might be added. The object of such records is not to be able to show merely a well-written exercise-book on any stereotyped model, but to induce young people to observe and to take the trouble to record the phenomena which are noticeable round about them. I am not sanguine enough to imagine that the attempt to encourage observation among our school-children will work any great revolution among them, or in our method of teaching them, but it is an effort in the right direction, and if it only led half a dozen young people to keep a record of what they saw it would have justified itself. The lack of observation among even those whose occupation brings them every day into close contact with the things of nature is to me one of the marvels which I meet with. I have employed and met with many working gardeners, but I do not know one among them who can give a correct name—I mean a trivial, not a botanical name—to the weeds which are met with in every garden. They know chickweed, groundsel, docks, sorrel, and couch-grass—perhaps altogether as many as they could count on the fingers of both hands, but there their knowledge stops. They turn up larvæ and come across caterpillars, but cannot connect them with the beetles and moths which fly around them. And what is true of gardeners is equally true of farmers and others engaged in outdoor pursuits. When a Thomas Edwards or a Robert Dick appears among the so-called working-classes he is looked upon as a remarkable phenomenon, whereas he ought to be looked on rather as a more than ordinarily enthusiastic observer. Of course, in one sense a man may not be much the better of knowing anything about the things that lie under his nose, as long as he is a faithful worker and can earn his bread without such knowledge. Yet the marvel is that, being blessed with eyes and a brain, he should not develope some curiosity in them, especially as he has the means largely in himself of satisfying that curiosity. The faculty of observing is usually well developed relatively to other mental faculties in children, and it should be part of every child's subsequent training to continue this development. We talk a great deal about doing this in our educational work, and a distinct move towards it has been made in the growing use of kindergarten methods in our infant schools, but the real thing is a great way off. The examination curse dominates everything. Departments and Boards want everything in the shape of a written report and a tabulated form. Cut-and-dried schemes of examination are so much more easy to work with and to report about than any individuality of teaching-power in a man. That originality tends to be stamped out unless it is very conspicuous and assertive. In our own primary schools apparent provision is made for the teaching of natural science, but to attempt to examine the subjects on the lines of text-books, as is so liable to be done, is almost fatal to the work. It reduces the thing to memory work, of which the tendency is to make too much already. What is wanted is to a great extent to banish text-books, and to work from the objects themselves, and

anything that will tend to foster observation and record of observation at first hand is to be commended. Now, a proposal such as we make is a move towards the encouragement of first hand observation. It is one which wants the co-operation of teachers in order to direct the minds of pupils, and to show them how to keep proper records. At the same time the records, to be of any real value, must be the result of individual attention. If any one, for instance, who works in a garden takes the trouble even for one year to keep a simple calendar of dates both of work done and of results gained, it is wonderful how interesting the record becomes as the recurring seasons bring round the same chain of events. There is probably no subject that can supply such a perennial source of interest as the study of nature. The desire for more knowledge grows with what it feeds on, but there is no possibility of satiating the desire with over-indulgence, or of exhausting the supply of material. The cultivation of an observational habit may prove in after days a source of joy and a means of stimulation when many other springs of action fail. A hobby is, as a rule, and when indulged in in moderation, an excellent thing for a man. Nothing is more sad than to see a man, retired or superannuated from some occupation to which he has devoted all his thought and energy for the best years of his life, wasting for lack of occupation. Many such men die off after a few years, simply because their faculty of being interested has become atrophied—at least, of being interested in things which are within their means and power of attainment. Now, it may seem a far cry between the observation of a youngster at school and the occupation of a man who has worked out the greater part of his career. But the habits of life must be moulded in the most plastic time of both mind and body; hence anything that tends to develope the free use of the mind in a healthy direction should be taken advantage of. There is nothing easier than to fall into purely mechanical methods of teaching; there is nothing more difficult to avoid when results are measured by the ability to pass a set examination; and teachers and parents alike should welcome anything that will bring to the juvenile mind freshness and originality. It is in this spirit that the Council of this Institute wishes to make a simple experiment, and asks the co-operation of all true educationists in its efforts.

Having read the above communication, Mr. Hamilton said the lines upon which observations were asked were indicated in the following draft of a circular which it was proposed to send to the Education Board for printing and distribution in the schools :—

"With the object of promoting an interest in natural phenomena, and of fostering the habit of placing on record such facts of observation as daily come under notice, the Otago Institute offers for competition next year ten prizes to the scholars of any public school in Otago under the following conditions :—

"The prizes will be awarded for the best-kept note-books in which are recorded any facts of observation, such as the occurrence of birds, insects, plants, &c., met with in the neighbourhood or during walks; the date at which birds' eggs were found, with observations on their nests, habits, &c.; the date of leafing, flowering, and fruiting of wild and cultivated plants; the weather of each day, &c. Most value will necessarily be attached to accuracy and closeness of observation, but neatness of the work and consecutiveness of the notes will also be considered. There should be no attempt at fine writing, but a plain record of facts.

"For the purposes of this competition the notes should close on the 30th November, 1899, though it is hoped that once the habit of keeping such a record is started it will be continued. The competition is open to all pupils who, on the 30th November, 1899, are in the sixth or any lower standard. While it is hoped that teachers will interest themselves in thus fostering observation, and will, during the remainder of this year,

give their pupils hints and suggestions as to how to go to work, it must be understood that the notes must be *bonâ fide* the work of the pupils themselves. Appended is a sample of an actual record, which may serve as a sort of rough guide."

The Chairman said he was sure the members of the Institute would indorse every word contained in the suggestions. The Council had unanimously agreed upon sending the circular just read to the Education Board, and he hoped that that would receive the indorsement of members also.

Mr. W. Brown thought the proposal was an admirable one, and that the Institute should give it its full support. He did not know of anything that would tend to cultivate habits of observation more than what Mr. Thomson had suggested. He had much pleasure in moving that the suggestions be given effect to.

The motion was agreed to.

2. "Notes on New Zealand Earthworms," by Professor W. B. Benham, D.Sc. (*Transactions*, p. 156.)

Dr. Hocken and Mr. G. M. Thomson spoke on the subject-matter of the address, and joined in welcoming Dr. Benham to fresh fields for a further study of that group of animals in which he has already a world-wide reputation.

Dr. Hocken exhibited some spirit specimens of the Palolo, a marine worm that periodically appears from the coral-reefs in Fiji and other places, and which is collected and eaten by the natives.

Mr. Hamilton then gave a short sketch of "The Art of War as practised in Old New Zealand," describing the Muru system, and the various ceremonies enacted in tribal warfare. At the close of his remarks Mr. Hamilton exhibited a number of specimens of war belts and girdles from the Urewera country.

Dr. Benham exhibited a new species of Nudibranch.

3. Mr. Hamilton read a paper "On a Maori Chert Quarry," and exhibited a chert knife which he had obtained from a Maori chert quarry near Roxburgh.

He explained that the knives were used by the Maoris for ordinary cutting purposes, and also stated that some years ago the President of the Institute had described a chert quarry which existed in the Mackenzie country. No doubt many more would yet be discovered.

Some specimens of native spring flowers were also shown by Mr. Hamilton, grown in Mr. H. Matthews's garden, at Mornington.

Mr. Hamilton stated that he had received a letter from Dr. Young, of Invercargill, in regard to the bird which was exhibited at the last meeting of the Institute—viz., the celebrated *Notornis*.

He said the doctor informed him that the owner, Mr. Ross, had kindly consented to make a considerable sacrifice, from his point of view, so that the bird should be retained in the colony. Mr. Ross's patriotism was such that he said if the Institute could succeed in raising £250 he was prepared to accept that amount, so that the bird should remain in

the colony, and he would not seek for a better offer outside. He had already received an offer of a greater amount than that from another country, and he (Mr. Hamilton) had no doubt that he could obtain a higher price if he put it in the open market. He (the speaker) might be permitted to say that, much as he should like to see the bird added to our Museum treasures, he must still adhere to the views which he partly expressed at last meeting—viz., that the capture of another bird—a young female—pointed to the fact that there must be other specimens of the bird still existing; and he thought that, if the members of the Institute felt inclined to raise any money, that money would be better expended in undertaking a private search for living specimens, which should be preserved on Resolution Island.

The Chairman said, no doubt Mr. Ross's offer was a most public-spirited one; but still it was entirely beyond the means of the Institute to spend so much money in the purchase of the bird. It would be a thousand pities if the bird left New Zealand, and it might be possible to make some public appeal to raise the necessary £250 for the purchase of the bird.

Mr. Hamilton did not for a moment contemplate that the Institute would spend £250, but it could head a public subscription with a substantial amount. However, even if a public subscription were raised, and the Government contributed a certain amount, he still adhered to the views he had expressed on the subject.

The Chairman said they could not do less than send a grateful note of thanks to Mr. Ross and Dr. Young, and he would propose that.

Mr. Melland suggested that the Government should be asked to buy the bird from Mr. Ross, and that Mr. Henry should accompany Mr. Ross on an expedition with the view of seeing if they could catch some live specimens of the bird.

Dr. Benham was quite in agreement with previous speakers in saying that they should not spend so much money on the purchase of the bird. The Institute ought, however, to thank Mr. Ross and Dr. Young for allowing them to have the bird on exhibition for so long a period. It had been a source of great pleasure to themselves, and to a good many people who had come to the Museum to see it.

Mr. Smith moved, That the Government be asked to purchase the bird.

Mr. Melland seconded the motion, which was carried.

It was also decided to write to Mr. Ross and Dr. Young, thanking them for the offer they had made in connection with the bird.

The Chairman, in his closing remarks, drew the attention of the members to the death of Mr. John Buchanan, F.L.S., and feeling reference was made to the large amount of useful botanical work done by him. Mr. Buchanan was one of the oldest members of the Otago Institute, and in conjunction with Dr. Hector had collected largely in Otago when attached to the Provincial Geological Survey Department.

Seventh Meeting: *18th November, 1898.*

The annual meeting of the members of the Otago Institute was held in the lecture-room at the Museum. Mr. F. R. Chapman, President, occupied the chair.

Abstract of Annual Report.

Eight meetings of the Council and seven general meetings have been held. The membership of the Institute now stands at 116.

Early in the session the colony suffered a great loss in the death of Mr. T. Kirk, F.L.S. At the close of the session we have to note with regret the death of Mr. John Buchanan, F.L.S., another eminent botanist, and pioneer in scientific work in New Zealand; and last, but not least, the Right Honourable Sir George Grey, first President of the New Zealand Institute, and original President, in 1851, of the New Zealand Society—the first scientific society founded in New Zealand.

A committee has been set up to recommend books necessary for the library, and they have reported to the effect that monographs of the principal groups in the animal kingdom are specially required, and they have decided to take a separate group each year.

The Council trust that no time will be lost in making suitable arrangements for the completion of the work on the New Zealand flora, left incomplete by Mr. Kirk, as for many years the work has been urgently required.

The Council desires to recognise the satisfactory progress made by the New Zealand Institute in the publication of the valuable work by Mr. A. Hamilton on "The Art and Ethnology of the Maori."

Since the last annual meeting matters have been almost at a standstill *re* the marine fish-hatchery at Purakanui, but we hope we shall soon be able to report favourably on the near prospect of the establishment of the proposed hatchery.

On the 8th December last, in reply to a letter from Mr. G. M. Thomson, the Secretary to the Marine Department wrote to say that the sum of £750 was placed on the supplementary estimates, and voted for "Fish-hatcheries and expenses of Expert Ayson to Canada and America, but that nothing will be done by the Government in the matter of establishing hatcheries pending the return of the expert." Before his departure for America and Europe, Mr. Ayson came down to Dunedin and met some of the members of the committee and of the Otago Acclimatisation Society. As we understand that he has made excellent use of his time in visiting the principal hatchery establishments and biological stations of the Northern Hemisphere, and generally in obtaining information on the subject, we anticipate that he will be able to give a very full report of what is being done. As the amount asked by us from the Government as a subsidy was £500, and as Mr. Ayson's expenses would considerably exceed the extra £250 voted last year, we are glad to notice that an additional sum of £250 has been voted this session.

On the 22nd September the area indicated at Purakanui in our last report was gazetted as a reserve for a fish-hatchery.

We regret that no further communication has been received from the Scotch Fishery Board in regard to the experiments to be undertaken on behalf of this Institute in the retardation of fish ova. In reply, however, to Dr. Chilton, who made direct inquiry on the subject, Dr. Fulton, the scientific superintendent of the Scotch Board, stated that the delay was due to the transference of the Board's hatchery from Dunbar to Aberdeen, and that he would shortly forward a communication to us on the subject.

The receipts for the year ended the 7th November, including a balance brought forward of £27 9s. 3d., come to £86 5s. 3d. The expenditure during the same period came to £42 11s. 3d., leaving a balance in the Union Bank of £43 14s.

Election of Officers for 1899. — *President* — F. R. Chapman; *Vice-presidents*—Dr. Scott, A. Bathgate; *Council* —Professor Benham, Dr. Hocken, Dr. Shand, G. M. Thom-

son, B. C. Aston, E. Melland, Crosbie Smith; *Hon. Secretary*—A. Hamilton; *Hon. Treasurer*—J. S. Tennant; *Auditor*—D. Brent.

Address by the President, Mr. F. R. Chapman.

Abstract.

The President thanked the members of the Society for his re-election, but remarked that he supposed he had been proposed for a new term in consideration of his not having performed the duties during the past term. He also felt he had cause for thankfulness on account of his colleagues who had been elected. He proposed in his opening address, which he had not had time to prepare, to speak upon a subject which was becoming more and more one of general interest to all civilised communities—the conservation of scenery and of the natural objects connected with scenery. The subject, he remarked, was one that had received attention in all parts of the world, but up to a comparatively recent period it had not been deemed worthy of being included in the programme of State policy. The speaker spoke of the scenery of Switzerland and Alaska and Australia and New Zealand, referring to the means which were adopted for the conservation of natural beauties and places of interest. One of the greatest acquisitions in this colony was the national park acquired by the colony in the centre of the North Island some years ago, which had been a gift to the people by the Maori owners. There was in almost every county in New Zealand, the President remarked, some object worthy of preserving, and he wished to add his testimony to that of others as to the usefulness and attractiveness of such objects, and to urge upon people everywhere to prize and take care of little pieces of scenery in their own districts. It seemed to him, for instance, that such a place as the Nuggets should have been preserved. It seemed to him a pity that a considerable area had not been reserved there, as being the nearest place where they could get permanently and easily preserved a perfectly rough piece of ground as a park for an outlet for the people of Dunedin. It was not possible to conserve the bush in the hills here, because settlement must, as a matter of necessity, go on, but at the Nuggets there was a good deal of land that might have been preserved in its natural state. Whether or not the land was all alienated from the Crown he did not know, but if any was left it was certainly desirable to preserve some part of it as a national park between the Nuggets and the nearest point of Catlin's Beach. Local parties should form committees and local bodies sub-committees to take an interest in preserving places of natural beauty for the public and from destruction.

Mr. A. Bathgate expressed regret that the Water of Leith Valley had not been preserved for the public. At the present time picnic parties could not go to any suitable spot near Dunedin without trespassing on private property.

Mr. J. Allen, M.H.R., suggested that societies such as the Institute should bring under the notice of the Government spots that ought to be preserved as national parks, and that something should be done to recover suitable areas round about Dunedin for the enjoyment of the people.

Mr. Chapman, in his reply, said that the scenery on the West Coast, to which reference had been made, was indestructible—the Sounds could take care of themselves; but there was not occasion to alienate land there, for when settlement did go there it would be purely fishermen's settlements. As to reserves near towns, he had thought a good deal about that question. The only way to get them was to pay for them. Unfortunately, the land was alienated, and the process of destruction was going on. There was still a beautiful bush area under Flagstaff,

but every year it got narrower and narrower. The City Council had done something to preserve some areas at the head of the stream, but it was, of course, desirable that something more should be done.

The following botanical notes were received from Mr. B. C. Aston :—

List of Plants supplementary to the Dunedin Field Club's Catalogue of Dunedin Plants.

Indigenous.

Halorageæ.—Callitriche muelleri, *F. Sond.;* Flagstaff Hill, Dunedin.

Compositæ.—Olearia nummularifolia, *Hook. f.;* Maungatua, 2,000 ft. Raoulia grandiflora, *Hook. f.;* Maungatua, 3,000 ft. Cassinia fulvida, *Hook. f., var.* rubra, *Buch.;* Flagstaff Hill, Dunedin Reservoir (rare).

Ericeæ. — Cyathodes pumila, *Hook. f.;* Maungatua, 3,000 ft. Cyathodes colensoi, *Hook. f.;* Maungatua, 2,000 ft.

Solaneæ.—Solanum nigrum, *L.;* near Tomahawk Lagoon.

Plantagineæ.—Plantago triandra; Tomahawk Lagoon.

Scrophularineæ.—Glossostigma elatinoides, *Benth.;* Wycliffe Bay. Veronica canescens, *T. Kirk;* Wycliffe Bay.

Introduced.

Umbelliferæ.—Torilis nodosa; St. Clair Cliffs.

Compositæ. — Cnicus arvensis (Californian thistle); common. Arctium majus (giant burdock); Duke Street Reserve.

New Habitats for some Rare Otago Plants.

Hymenanthera angustifolia, *R. Br.;* Winton (rare).
Aristotelia colensoi, *Hook. f.;* Colac Bay.
Geum leiospermum, *D. Petrie;* Ben Lomond, 4,000 ft.
Tillæa sinclairii, *Hook. f.;* Wycliffe Bay.
Gunnera arenaria, *Cheeseman, var.* depressa; Fortrose.
Gunnera dentata, *T. Kirk;* Lowther, near Lumsden.
Panax anomalum, *Hook. f., var.* microphylla, *Col.;* Sandymount.
Pseudopanax ferox, *T. Kirk;* Green Island, Clifden, Gore.
Coprosma virescens, *D. Petrie;* Clifden (Waiau River).
Coprosma vulva, *D. Petrie;* Clifden (Waiau River), Tapanui.
Olearia nummularifolia, *Hook. f.;* Colac Bay, Kingston.
Celmisia petiolata, *Hook. f., var.* rigida; Mason's Bay, Stewart Island.
Helichrysum purdiei, *D. Petrie;* St. Leonard's, Blanket Bay.
Cyathodes pumila, *Hook. f.;* Blue Mountains, 3,000 ft. (abundant).
Myrsine nummularia, *Hook. f.;* under bog-pines, Blue Mountains, 3,500 ft.
Teucridium parviflorum, *Hook. f.;* Clifden, North Otago Heads.
Pimelea sericeo-villosa, *Hook. f.;* Ben Lomond, 4,000 ft.
Sarcochilus adversus, *Hook. f.;* St. Leonards, Blanket Bay.

Plants omitted from Messrs. Kirk and Petrie's Lists of Otago Plants (Volumes XXVIII. and XXIX., Transactions).

Colobanthus muelleri, *T. Kirk;* Fortrose, *B. C. A.;* Stewart Island, *T. Kirk.*

Cassinia fulvida, *Hook. f., var.* rubra, *Buchanan;* Flagstaff Hill and Reservoir, Dunedin.

Cotula minor, *Hook. f.;* Stewart Island, *T. Kirk.*

Plantago triandra; Tomahawk Lagoon, *B. C. A.*

Hedycarya dentata, *Forst.;* near Port Chalmers, *T. Kirk;* West Coast Sounds, *T. Kirk;* "common in Otago," *Hector and Buchanan:* Hooker's Handbook, 1864, p. 739.

The following is a list of genera of fresh-water Algæ collected and noted in the Dunedin district during the summers of 1896–97 by Mr. J. S. Tennant, B.Sc.:—

1. Pleurococcus
2. Palmella
3. Protococcus
4. Chlorococcus

Common in all damp places; walls, fences, &c.

5. Volvox. Clear standing water.
6. Zygnema. Very common, ditches, ponds, &c.
7. Spirogyra. Very common, ditches, ponds, &c.
8. Vaucheria. Ponds, ditches, and damp places.
9. Ulva
10. Monostroma
11. Enteromorpha

Tomahawk Lagoon.

12. Cladophora. Running water.
13. Conferva. Very common.
14. Œdogonium. Running water.
15. Ulothrix. Common on damp ground.
16. Draparnaldia. Silverstream.
17. Stigeoclonium. Running water.
18. Chroococcus. Very common.
19. Glaeocapsa. Very common.
20. Oscillaria. Running water and damp cliffs.
21. Lyngbya. Silverstream.
22. Rivularia. Silverstream.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *9th May, 1898.*

The President read the inaugural address, taking as his subject "The State in Relation to Public Health."

Second Meeting: *13th June, 1898.*

Mr. W. Dinwiddie delivered a popular lecture on "The Comic in Art," illustrated by a number of lantern-slides.

Third Meeting: *11th July, 1898.*

Paper.—"National Pensions—a Proposed Scheme," by H. Hill, B.A., F.G.S. (*Transactions*, p. 683.)

Fourth Meeting: *22nd August, 1898.*

Mr. Hill exhibited—(1) Toki; (2) ancient stone sinker; (3) obsidian; (4) several specimens *Dactylanthus taylori*.

Fifth Meeting: *12th September, 1898.*

Paper.—"The Rivers of the Hawke's Bay Plains," by F. A. Tregelles, C.E., illustrated by diagrams and lantern-slides.

Sixth Meeting: *21st September, 1898.*

Mr. T. Tanner delivered a popular lecture on "The Geological History of the World," illustrated by fifty lantern-slides and several diagrams.

Seventh Meeting: *17th October, 1898.*

Papers.—1. "Phænogams: A Description of a few more Newly Discovered Indigenous Plants; being a Further Contribution towards making known the Botany of New Zea-

land," by the Rev. W. Colenso, F.R.S., F.L.S. (*Transactions*, p. 266.)

2. "A Description of some Newly Discovered Indigenous New Zealand Ferns," by the Rev. W. Colenso, F.R S., F.L.S. (*Transactions*, p. 263.)

3. "A Graphic Method of determining Azimuth Altitude and Hour Angle of a Star when at its Greatest Altitude," by C. E. Adams, B.Sc., A.I.A.

4. "Phrenology," by W. Dinwiddie.

5. "Vaccination," by Dr. Leahy.

6. "A Maori Earthwork Fortification," by Taylor White.

7. "A Maori Stronghold," by Taylor White.

8. "Are they Old Kumera-pits?" by Taylor White.

Eighth Meeting: *2nd November, 1898.*

Mr. T. Tanner delivered a popular lecture on "Prehistoric Man and Evolution," illustrated by a number of lantern-slides.

Annual Meeting: *6th February, 1898.*

Abstract of Annual Report.

Six ordinary and two extraordinary meetings were held during the year. The attendance was good, and increased interest was manifested. The number of members on the roll is sixty. Regret was expressed at the loss sustained in the death of Mr. J. W. Carlile, an ex-president of the Institute. Eleven papers were read, and three lectures delivered. Two series of weekly science lectures on university extension lines—twelve lectures in all—were delivered. The subjects dealt with were electricity and magnetism by Dr. Milne-Thomson, and chemistry by Dr. Jarvis, and the Council express their appreciation of the services of these gentlemen, and their gratitude to Mr. R. D. D. McLean for his donation of £10 to start a fund for providing scientific apparatus for the Institute. Fifteen meetings of the Council were held. Among the additions to the library were a specimen copy of the Rev. W. Colenso's Maori dictionary, presented by the author, and a fine set of Cook's Voyages, eight volumes text and one volume plates, donated by Mr. Hugh Campbell. The finances of the society are in a satisfactory state.

The balance-sheet showed that the total receipts, inclusive of a balance of £8 8s. from the preceding year, were £111 1s. 6d., while the expenditure was £97 7s. 5d., leaving a balance in hand of £23 14s. 1d. The assets were set down as £841 9s. 1d.

Election of Officers for 1899.—*President*—T. Tanner; *Vice-president*—J. E. H. Jarvis, M.R.C.S.; *Council*—R. D. D. McLean, M.H.R., J. Caughley, H. Hill, B.A., F.G.S., A. Milne-Thomson, M.B., C.M., W. Dinwiddie, T. C. Moore, M.D.; *Hon. Secretary*—James Hislop; *Hon. Treasurer*—J. W. Craig; *Hon. Auditor*—J. R. Crerar; *Hon. Curator*, A. Norris, F.E.S.

WESTLAND INSTITUTE.

THE annual meeting was held in the library, and was fairly well attended. T. H. Gill, Vice-president, in the chair.

ABSTRACT OF ANNUAL REPORT.

The report contained a full statement of the work of the society for the year. It stated that in some measure it had been an eventful one, and that the present position of the society was about an average one, but with some promises for the future, which, if fulfilled, would assist and help the society to increase its usefulness, and likewise improve the members' roll, which now contains sixty names. The trustees have held nine ordinary meetings, which have been well attended. The library is fairly well used, and the reading-room is found very useful by the general public, and is much availed of in the evenings, being well supplied with papers. A vote of thanks was recorded to those proprietors who donate papers, likewise to the Borough Council for its subsidy.

The balance-sheet showed—Receipts, £106 3s. 3d.; expenditure, £99 3s. 3d., leaving a credit balance of £7.

ELECTION OF OFFICERS FOR 1899.—*President*—T. H. Gill; *Vice-president*—G. K. Sinclair; *Hon. Treasurer*—A. Mahan; *Trustees* — Messrs. Morton, Clarke, King, Dawes, Beare, Michel, Falla, Perry, Macfarlane, McNaughton, and Drs. Macandrew and Teichelman.

NELSON PHILOSOPHICAL SOCIETY.

Annual Meeting: *24th April, 1899.*

The Bishop of Nelson, President, in the chair.

Abstract of Annual Report.

The Hon. Treasurer, being on a visit to England, was appointed by the Council as its delegate to the International Zoological Congress held at Cambridge.

The Museum was reported in good order.

The Treasurer's statement showed receipts (including balance brought forward) amounting to £22 16s. 4d., and the expenditure £13 3s. 1d. Of this amount £7 7s. had been expended on the upkeep of the Museum.

The thanks of the Society were tendered to the Hon. Secretary, Mr. R. I. Kingsley, for the important services rendered and persistent loyalty to the aims and objects of the Society.

Election of Officers for 1899.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. Mackie; *Council*—Dr. Boor, Rev. F. W. Chatterton, and Messrs. Gibbs, Lukins, and Bartell; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. Hudson; *Hon. Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins.

APPENDIX

METEOROLOGY.

Comparative Abstract for 1898 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously. Fahr.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean. Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation = 100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year.	Maximum Velocity in Miles in any 24 hours, and Date.	Mean Amount (0 to 10).
Auckland...	30·081	1·200	58·7	12·7	50·0	146·0	36·0	0·360	72	40·750	174	...	...	5.1
Previous 34 years ...	29·996	...	59·0	...	...	...	...	0·382	72	42·142	182	...	...	...
Wellington	29·912	1·508	55·2	12·8	45·4	138·0	19·0	0·318	72	41·962	162	245	840 on 17th June.	4·4
Previous 34 years ...	29·928	...	54·8	...	...	...	...	0·332	72	51·247	161	...		...
Dunedin	29·758	1·704	49·6	15·1	63·0	148·0	24·0	0·269	75	34·143	170	177	550 on 10th March.	5·4
Previous 34 years ...	29·961	...	50·1	...	...	...	...	0·275	73	37·242	157	...		...

Average Temperature of Seasons compared with those of the Previous Year.

Stations.	Spring. September, October, November.		Summer. December, January, February.		Autumn. March, April, May.		Winter. June, July, August.	
	1897.	1898.	1897.	1898.	1897.	1898.	1897.	1898.
Auckland	56·4	57·2	66·1	64·7	60·4	66·1	52·4	52·8
Wellington	54·3	54·3	62·1	61·5	56·6	56·2	48·9	48·7
Dunedin	49·8	49·7	57·9	56·5	50·5	50·1	42·7	42·3

REMARKS ON THE WEATHER DURING 1898.

JANUARY.—Showery, with intervals of fine weather. Prevailing S.W. wind and often strong in North; generally fine over centre; and changeable and showery in South, and westerly winds.

FEBRUARY.—Generally fine in North and over centre, with fresh S.W. and N.W. winds; in South showery and cold.

MARCH.—On the whole a fine month, with fresh N.W. and S.W. winds, and showery at intervals; cold in South.

APRIL.—In North fine weather and moderate variable winds; over centre heavy rain and strong N.W. winds; in South cold and changeable, and light showers.

MAY.—Showery weather and strong N.E. winds, especially in early part; over centre heavy rain and strong N.W. winds, frequent fogs, and thunder; and in South showery, and fresh S.W. winds.

JUNE.—Heavy rain latter part, otherwise fine, with prevailing S. and S.W. winds; over centre showery towards end of month, and strong N.W. winds; frequent fogs. In South fine early part and showery towards end of month; prevailing S.W. winds, but moderate.

JULY.—A very wet stormy month in North, with S.W. winds, frequent thunder, and hail; also showery over centre, with thunder, hail, and snow, and strong N.W. winds; and in South cold and showery; winds S.W. generally, and frequent snow.

AUGUST.—In North a wet month, with N.E. gales in early part, a few fine days at end; over centre a showery cold month, with prevailing S.E. winds and fresh; frequent fogs; in South changeable in early part and fine towards end, and S.W. winds.

SEPTEMBER.—A showery but pleasant month in North, with moderate S.W. winds; over centre some heavy rain, with intervals of fine weather; prevailing N.W. winds and fresh. In South generally fine, with moderate winds.

OCTOBER.—In North generally showery, but some fine days; prevailing S.W. winds and strong; also strong N.E. towards end of month, and thunderstorms. Over centre stormy from N.W., but clear weather; fine middle of month, and showery and strong N.W. wind during latter part. In South changeable and showery weather, with S.W. winds.

NOVEMBER.—In North generally fine, with S.W. winds, strong at commencement but generally moderate; over centre showery first half, and the latter part fine; prevailing N.W. winds, and generally strong. In South showery early part and fine during latter part, with S.W. and W. winds.

DECEMBER.—In North some fine weather, but on the whole showery, with N.E. and S.W. winds; over centre a fine month, with light showers; prevailing N.W. winds and often strong. In South showery during middle of month, but fine early and latter parts; moderate variable winds.

EARTHQUAKES reported in NEW ZEALAND during 1898.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Rotorua ..	..	..	..	..	4*	..	..	29	..	..	..	..	2
Taupo ..	..	..	..	..	..	..	..	..	..	..	..	4*	1
New Plymouth	..	..	..	..	..	..	8	..	..	..	..	..	1
Napier ..	..	..	..	..	..	..	5*	13	..	..	..	4*	3
Hastings ..	..	..	..	..	..	..	5*	..	..	..	10*	..	2
Woodville ..	..	..	..	..	..	..	8	..	..	..	..	..	1
Palmerston N.	22*	..	..	..	..	..	..	..	..	..	..	..	1
Mauriceville..	22*	..	..	..	..	..	..	..	..	..	..	..	1
Wellington ..	..	13	10	..	3, 8, 16*	27	5, 8	7	16	..	..	30	11
Kaikoura ..	..	..	..	..	..	..	8	..	..	..	..	..	1
Wakapuaka..	..	..	..	..	..	..	8*	..	..	..	..	..	1
Lincoln ..	..	..	..	..	20	..	8	..	..	..	..	..	2
Christchurch	..	..	..	..	20*	..	8	..	..	..	..	..	2
Hokitika ..	..	..	..	..	..	..	8	..	..	..	..	..	1
Greymouth ..	..	..	..	..	..	..	8	..	..	..	..	..	1
Westport ..	..	..	..	..	..	..	8	..	..	..	..	..	1
Dunedin ..	..	..	..	..	27	..	..	..	..	..	..	..	1
Invercargill..	..	..	..	..	27*	..	..	..	..	..	..	..	1

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection, except at Wellington, which is the only station at which a seismograph records the shocks. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks.

NEW ZEALAND INSTITUTE.

HONORARY MEMBERS.

1870.

Finsch, Otto, Ph.D., of Bremen.
Flower, Sir W. H., K.C.B., F.R.S., F.R.C.S.
Hooker, Sir J. D., G C.S.I , C.B., M.D., F.R.S.

1873.

Cambridge, The Rev. O. Pickard, M.A., C.M.Z.S.
Günther, A., M.D., M.A., Ph.D., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.

1875.

Sclater, Philip Lutley, M.A., Ph.D., F.R.S.

1876.

Etheridge, Prof. Robert, F.R.S.
Berggren, Dr. S.

1877.

Sharp, Dr. D.

1878.

Müller, Professor F. Max, P.C., F.R.S.

1883.

Lord Kelvin, G.C.V.O., D.C.L., F.R.S.
Ellery, Robert L. J., F.R.S.

1885.

Sharp, Richard Bowdler, M.A., F.L.S.
Wallace, A. R., F.L.S.

1888.

McCoy, Professor Sir F., K.C.M.G., Sc.D., F.R.S.

1890.

Nordstedt, Professor Otto, Ph.D.
Liversidge, Professor A., M.A., F.R.S.

1891.

Goodale, Professor G. L., M.D., LL.D.
Davis, J. W., F.G.S., F.L.S.

1894.

Dyer, Sir W. T. Thiselton, K.C.M.G., C.I.E., LL.D., M.A., F.R.S.
Codrington, Rev. R. H., D.D.

1895.

Mitten, William, F.L.S.

1896.

Lydekker, Richard, B.A., F.R.S.
Langley, S. P.

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WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life-members.]

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Allen, F.
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Atkinson, A. S., Nelson
Baldwin, P. E.
Barker, G. H.
Barnes, R. J.
Barraud, W. F.
Barton, W.
Batkin, C. T.
Beetham, G.
Beetham, W. H.
Bell, E. D.
Bell, H. D.
Best, E., Hadfield
Blair, J. R.
Bothamley, A. T.
Brandon, A. de B.
Brown, W. R. E.
Buller, Sir W. L., K.C.M.G., D.Sc., F.R.S.
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Chapman, Martin
Chapple, Dr.
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Clarke, F. E., New Plymouth
Cohen, W. P.
Connal, E.
Davy, Dr. T. G., Kumara
Dawson, B.
Denton, George
Drew, S. H., Wanganui
Elliot, Major E. H. J.
Evans, W. P., M.A., Ph.D.
Ewart, Dr.
Ewen, C. A.
Farquhar, H.
Ferard, B. A., Napier
Ferguson, W., C.E.
Field, H. C., Wanganui
Fraser, F. H.
Freeman, H. J.
Gifford, A. C.
Gordon, H., F.G.S.
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Grace, Hon. M. S., C.M.G., M.D.
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Haylock, A.
Hector, Sir James, K.C.M.G., M.D., F.R.S.
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Herbert, W. H.
Hislop, Hon. T.
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Hudson, G. V., F.E.S.
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Inwood, D., Canterbury
Jenkins, Digby A.
Johnson, G. Randall*
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Kirk, H. B., M.A.
Kirk, T. W., F.L.S.
Krull, F. A., Wanganui
Lambert, T. S.
Lee, H. M.
Lee, R.
Liffiton, E. N., Wanganui
Litchfield, A. J., Blenheim
Lomax, H. A., Wanganui
Loxton, A.
Mackenzie, F. Wallace, M.B.
Marchant, J. W. A.

Martin, Dr. A.
Mason, Thomas, Hutt
Masters, Rev. F. G.
Maxwell, J. P., M.Inst.C.E.
McDougall, A.
McKay, Alexander, F.G.S.
McLeod, H. N.
McWilliam, Rev. J., Otaki
Mestayer, R. L., M.Inst.C.E.
Molineaux, B. M.
Moore, G.
Moorehouse, W. H. S.
Morison, C. B.
Murdoch, R., Wanganui
Nairn, C. J., Hawke's Bay
Newman, Alfred K., M.B., M.R.C.P.
Orr, Robert
Park, R. G.*
Pearce, E.
Pharazyn, C., Wairarapa
Phillips, Coleman
Pierard, C. H.
Pollen, Hugh
Powles, C. P.
Poynton, J. W.
Prendergast, Sir J., Chief Justice
Pringle, T.
Reid, W. S.
Richardson, C. T.
Rowse, Rev. W., Greytown
Roy, R. B., New Plymouth*
Rutherfurd, A. J.
Rutherfurd, W. G.
Rutland, Joshua, Marlborough
Samuel, E.
Schaw, Major-General, C.B., R.E.
Simcox, W. H., Otaki
Sinclair, J.
Singer, J., F.C.S.
Skerman, Dr. Sydney, Marton
Skey, W.
Smith, Charles, Wanganui
Smith, M. C.
Smith, S. Percy, F.R.G.S.
Stewart, J. T., Wanganui
Stowell, H. M.
Tait, P. W.
Talbot, Dr. A. G.
Tanner, Cyril
Travers, W. T. L., F.L.S.
Tregear, E.
Turnbull, A. H., London
Turnbull, R. T.
Turnbull, Thomas
Waley, A. S., London
Wallace, James
Waterhouse, G. M., F.R.G.S.
Welch, W., Palmerston N.
Wilton, G. W.
Woodhouse, Alfred James, London
Young, J.

AUCKLAND INSTITUTE.

[*Honorary and life members.]

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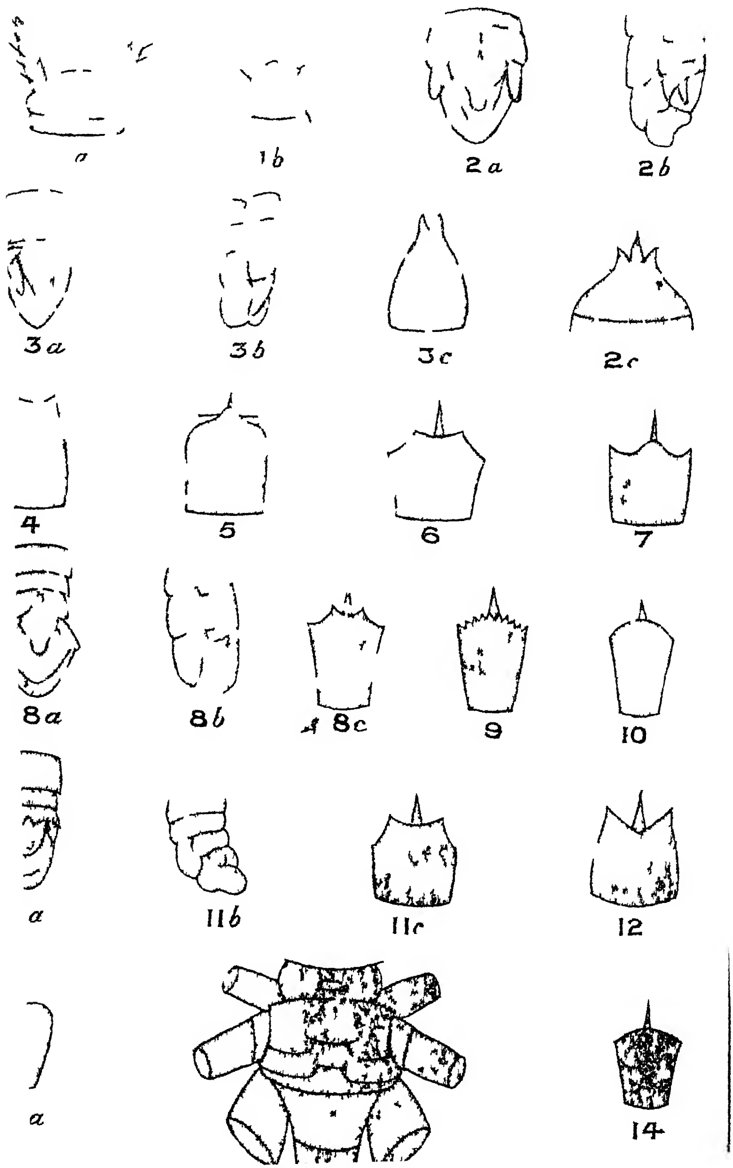
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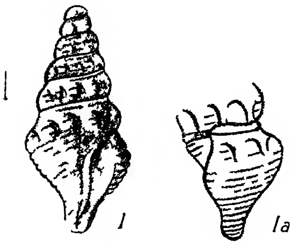

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Surcula verrucosa
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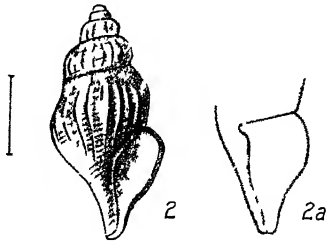

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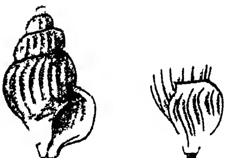

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Clathurella subabnormis
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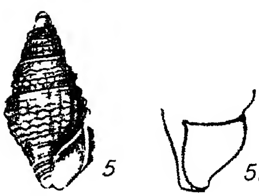

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Clathurella nodicincta
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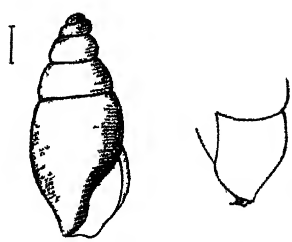
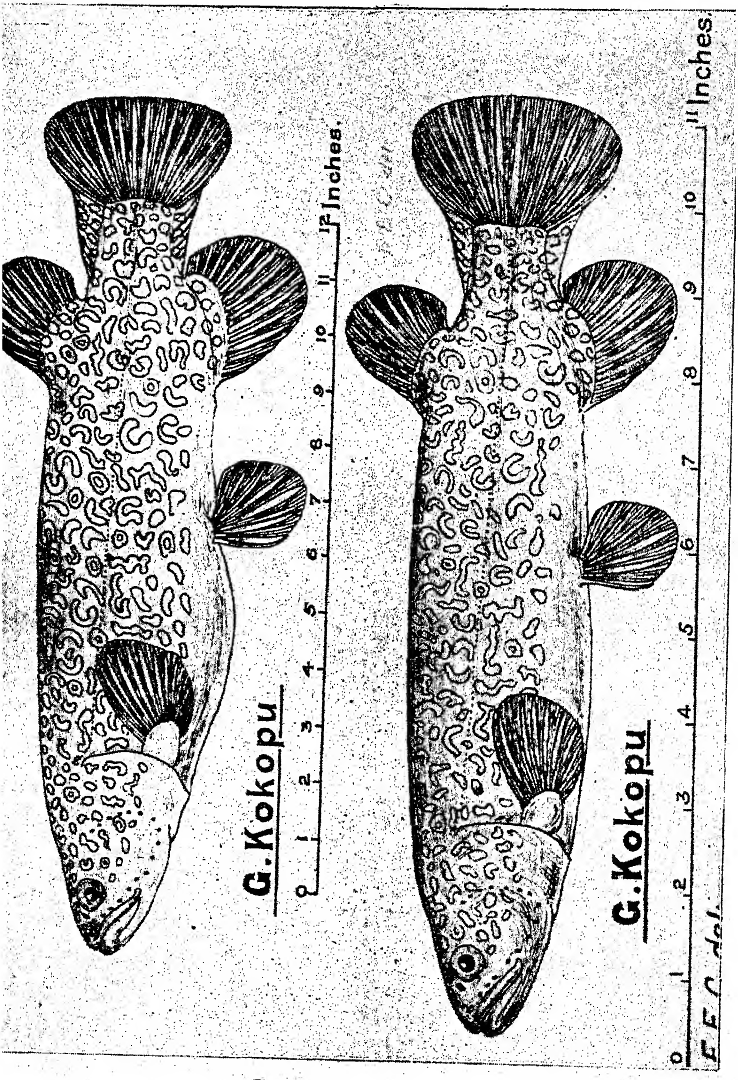


6 6a

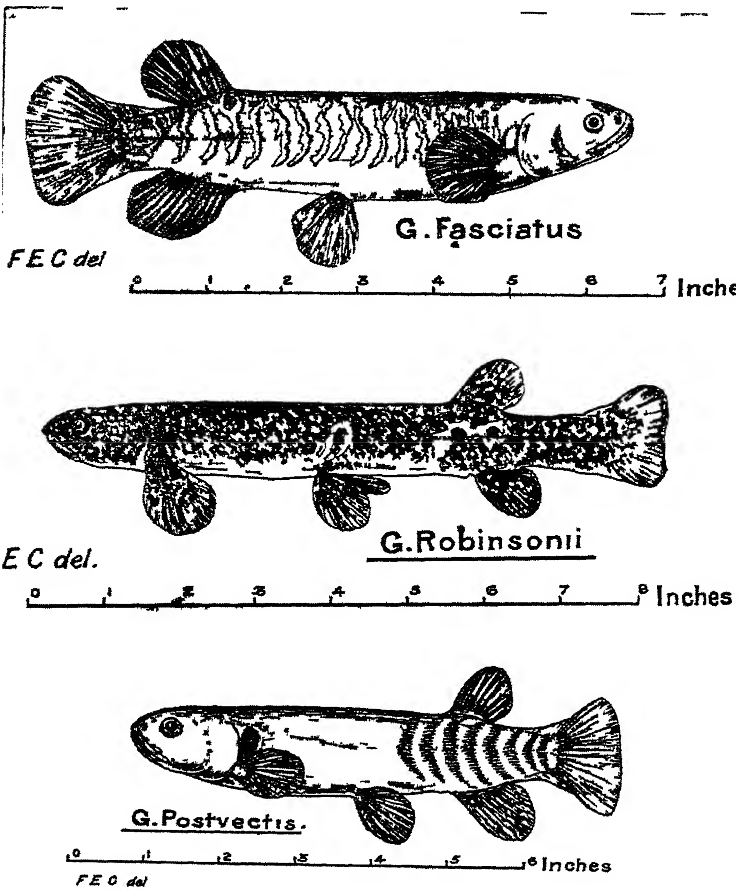
Daphnella substriata
6/1

PLEUROTOMIDÆ.
(Suter)

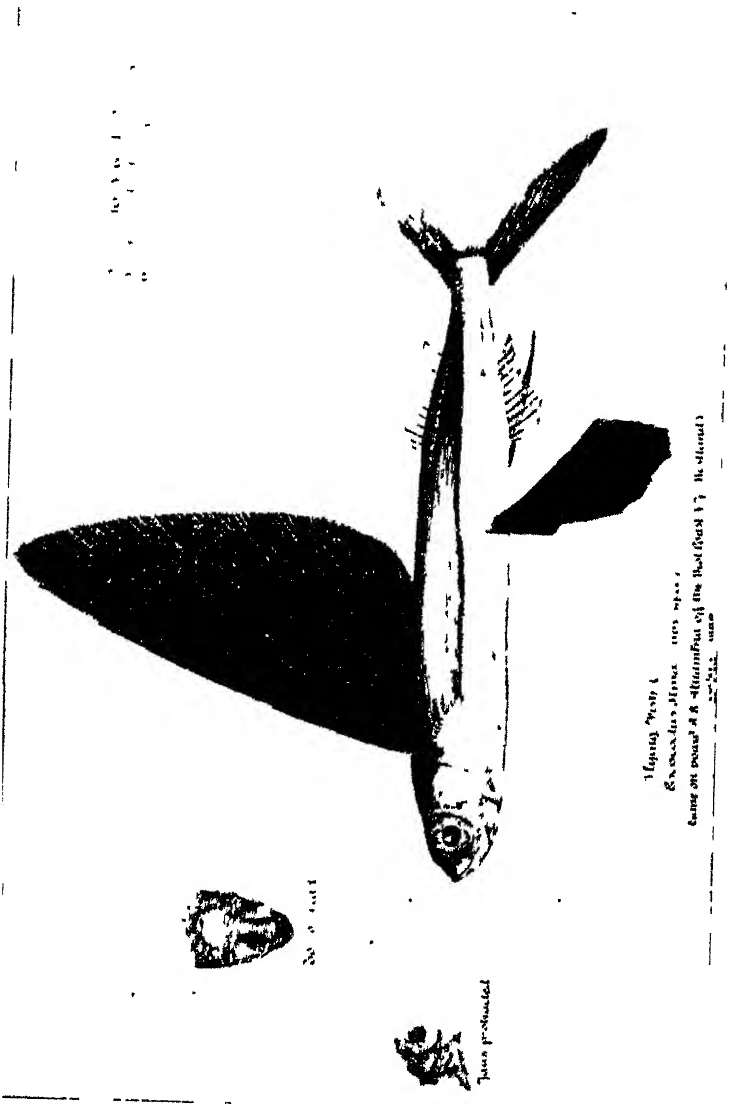


GALAXIDÆ

Clarke

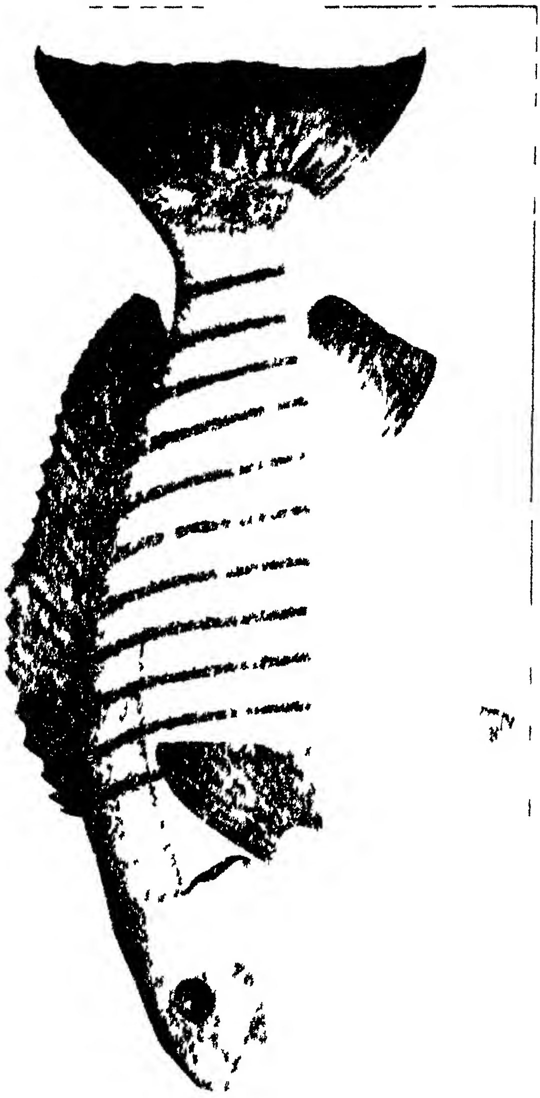


GALAXIDÆ.
Clarke

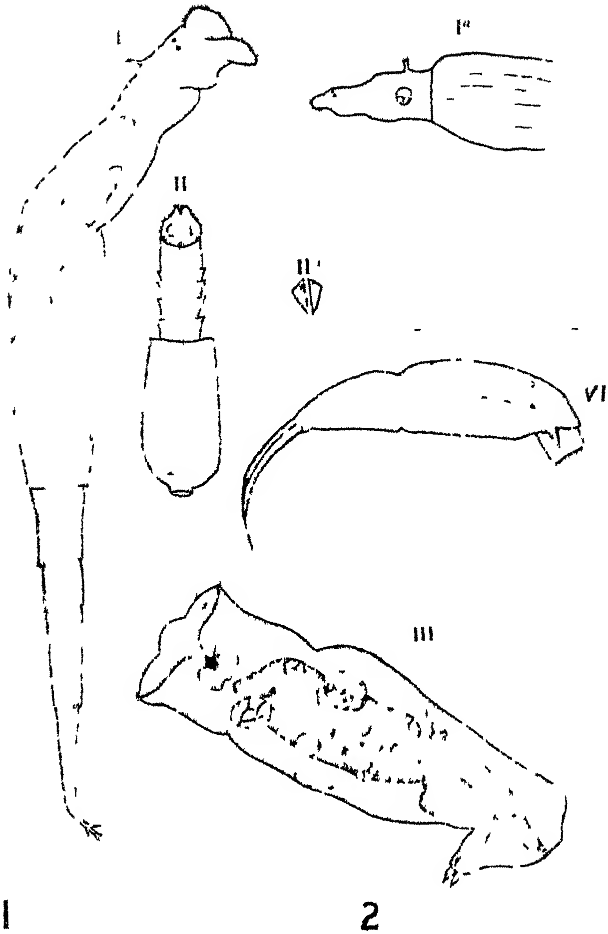


FLYING-FISH

Clarke

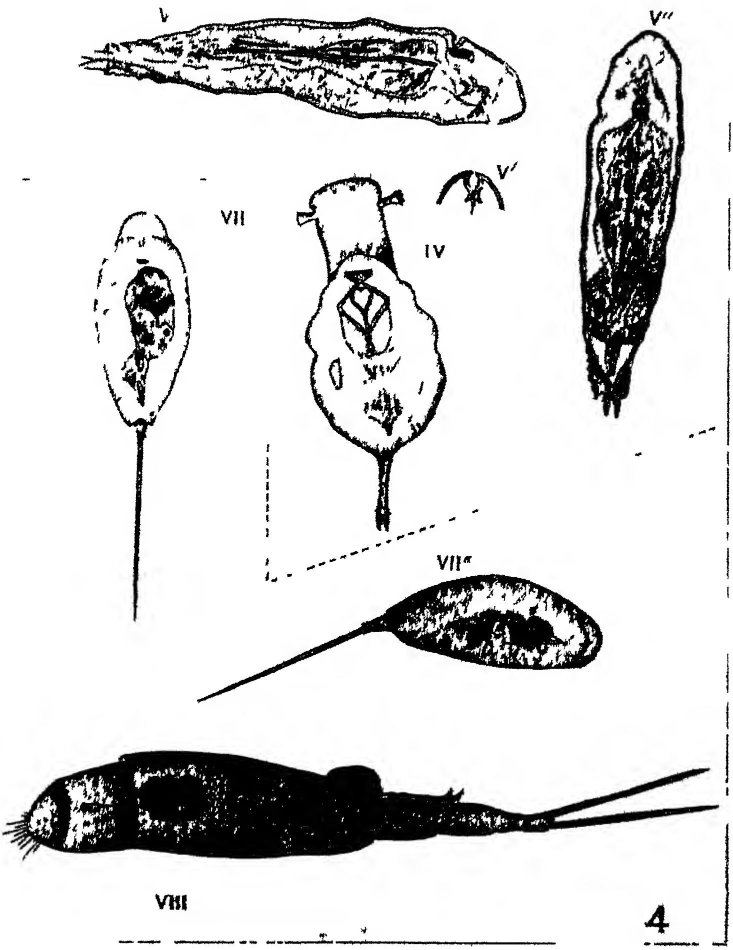


GIRELLA MULTILINEATA
Cl ık

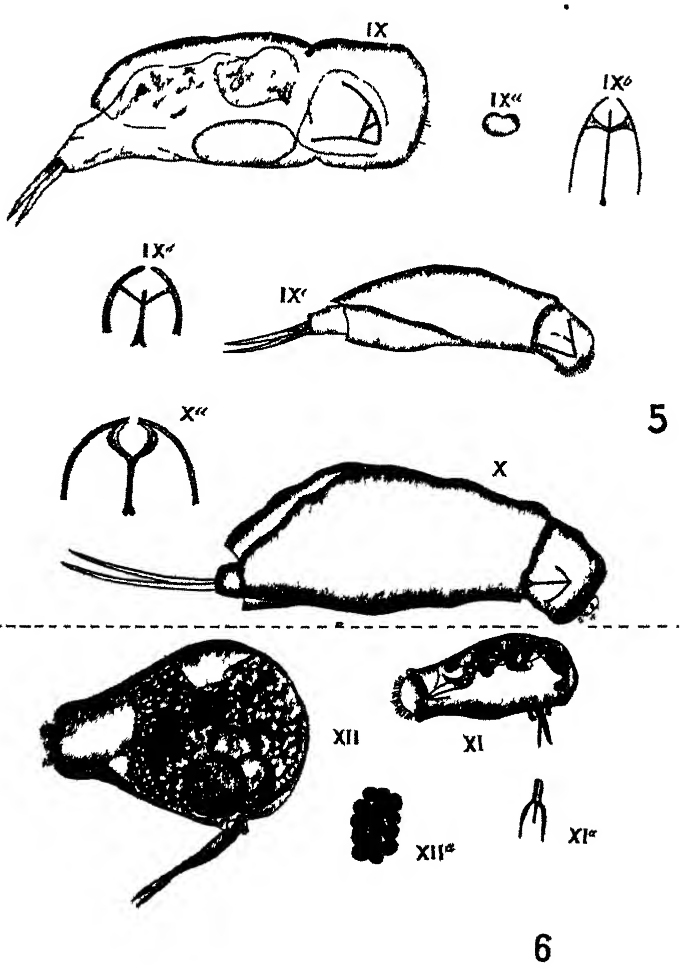


ROTIFERA.

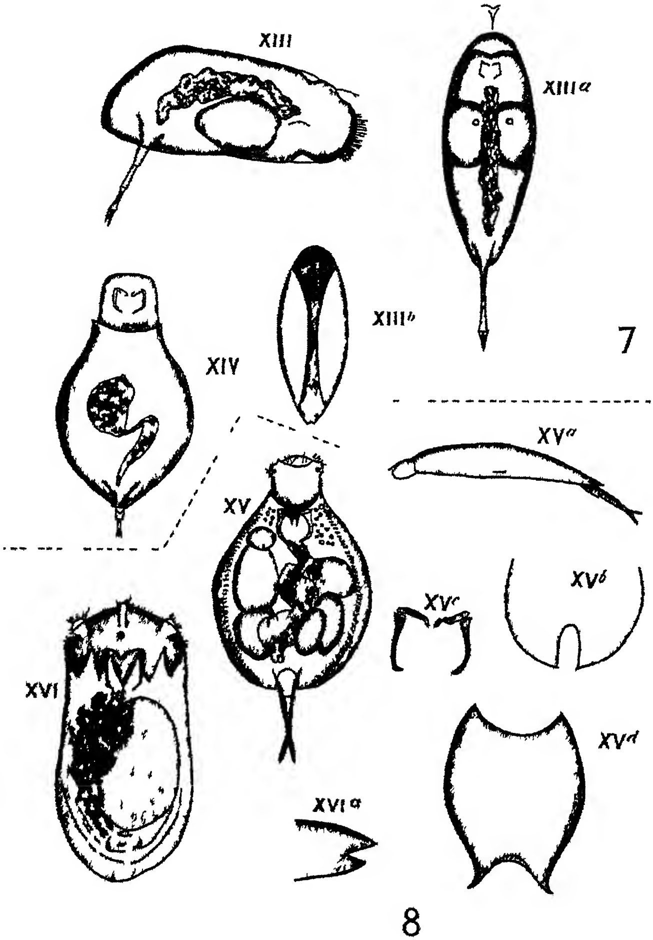
Hilgendorf



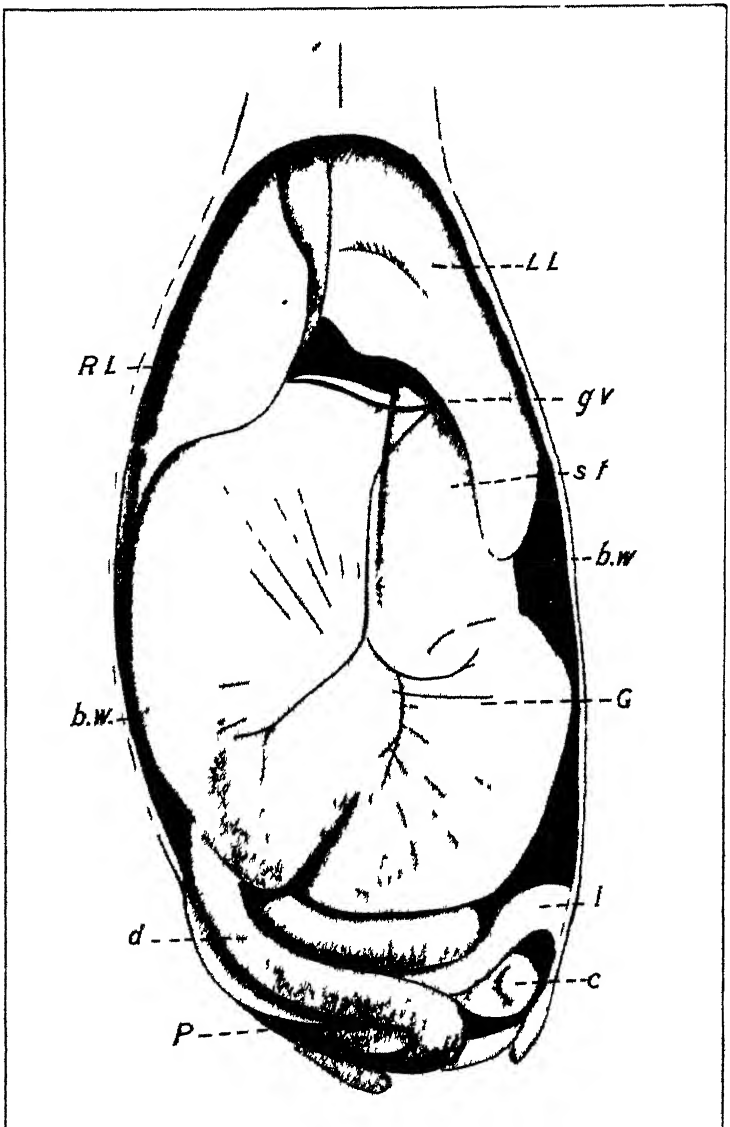
ROTIFERA
Hilgendorf



ROTIFERA
Hilgendorf



ROTIFERA.
Hilgendorf



VISCERA OF NOTORNIS

Benham

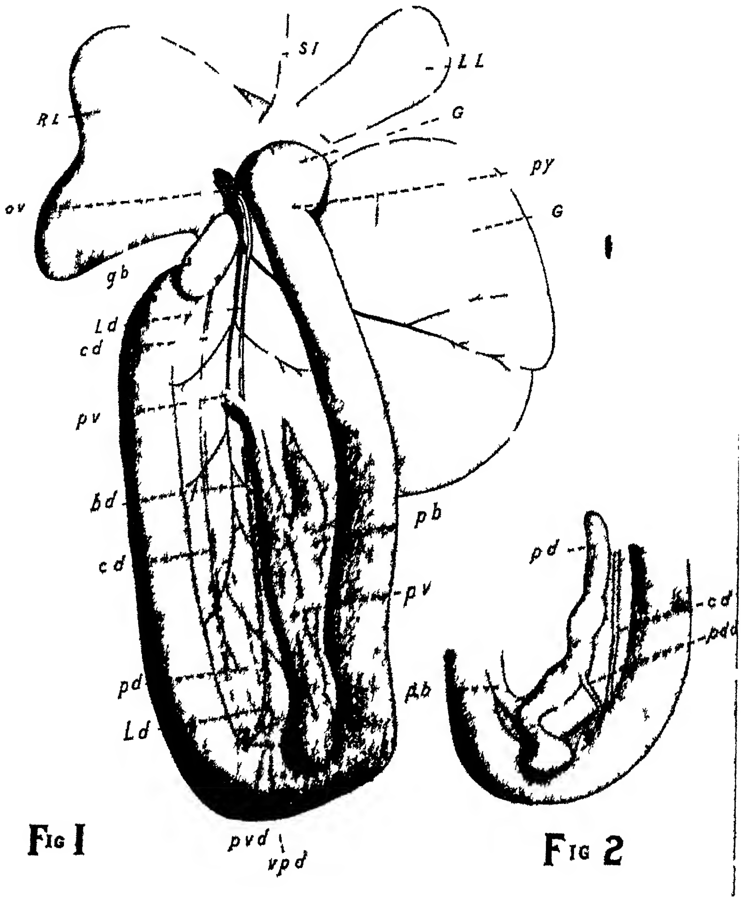
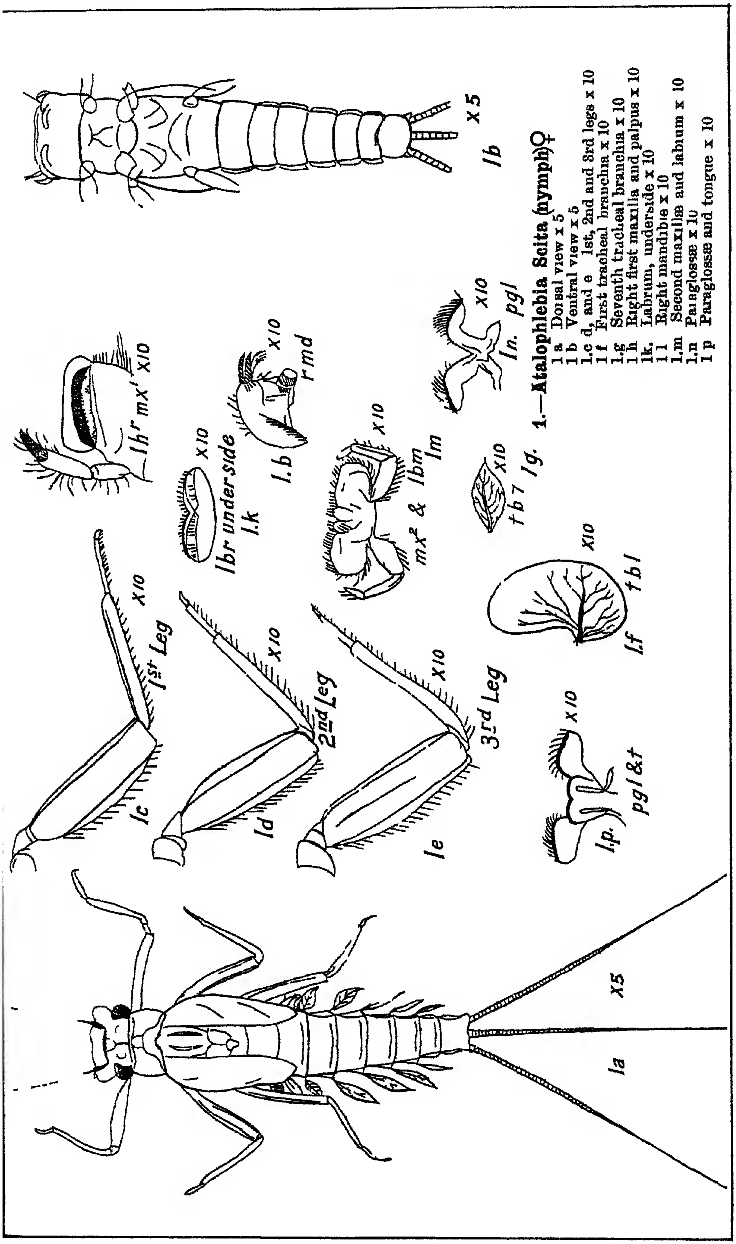


Fig I

Fig 2

VISCERA OF NOTORNIS

Benham

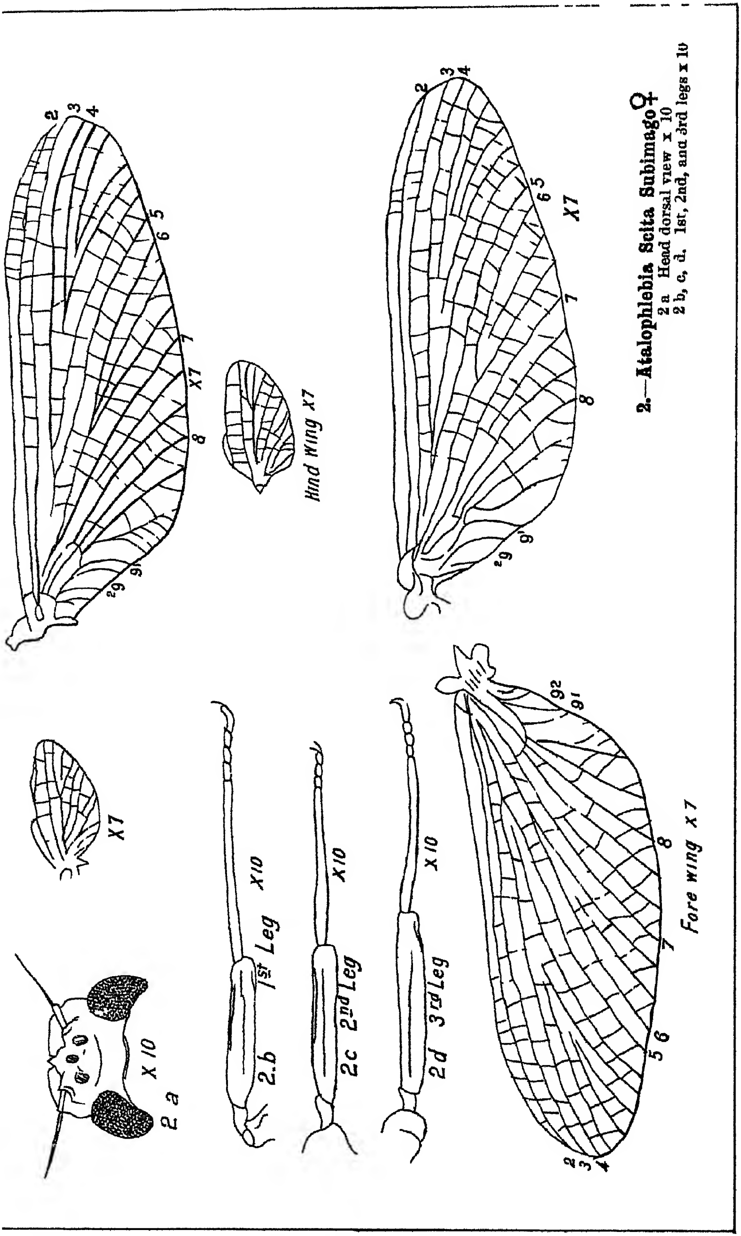


1.—Ataloplebia Scita (nymph) ♀

1 a Dorsal view x 5
1 b Ventral view x 5
1.c d, and e 1st, 2nd and 3rd legs x 10
1 f First tracheal branchia x 10
1.g Seventh tracheal branchia x 10
1 h Right first maxilla and palpus x 10
1k, Labrum, underside x 10
1 l Right mandible x 10
1.m Second maxillæ and labium x 10
1.n Paraglossæ x 10
1 p Paraglossæ and tongue x 10

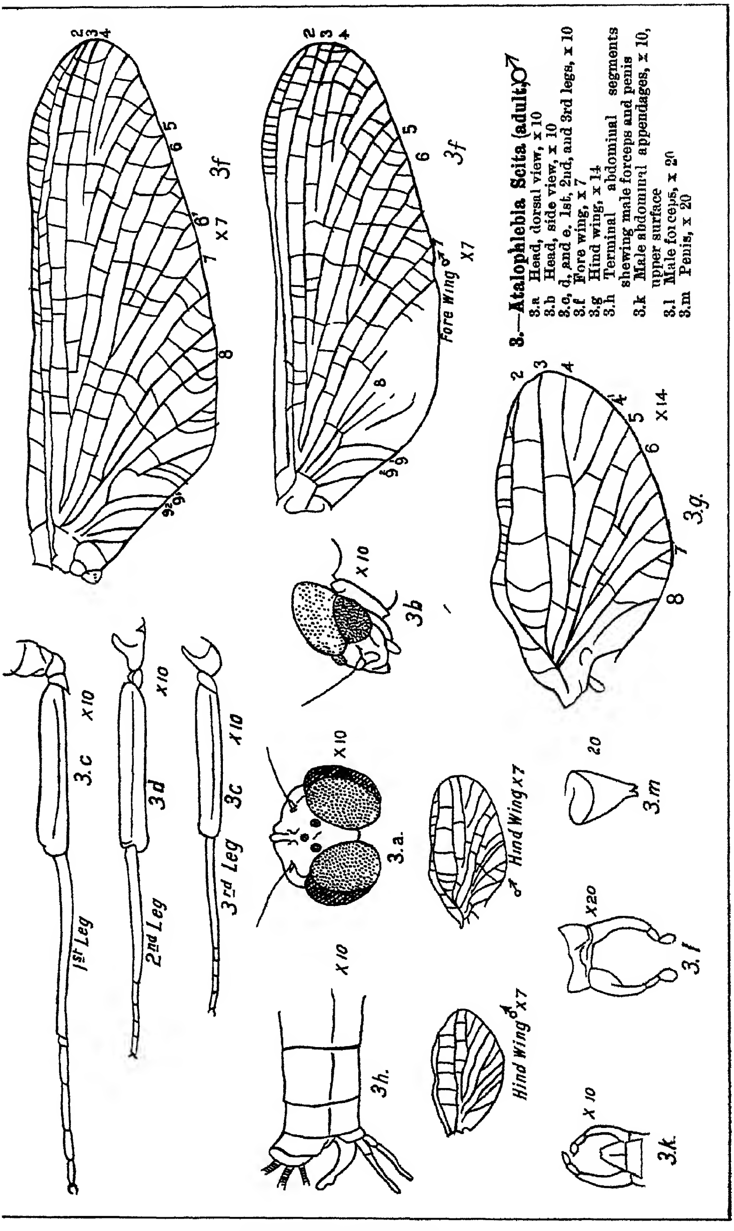
EPHEMERIDÆ

(Lillie)

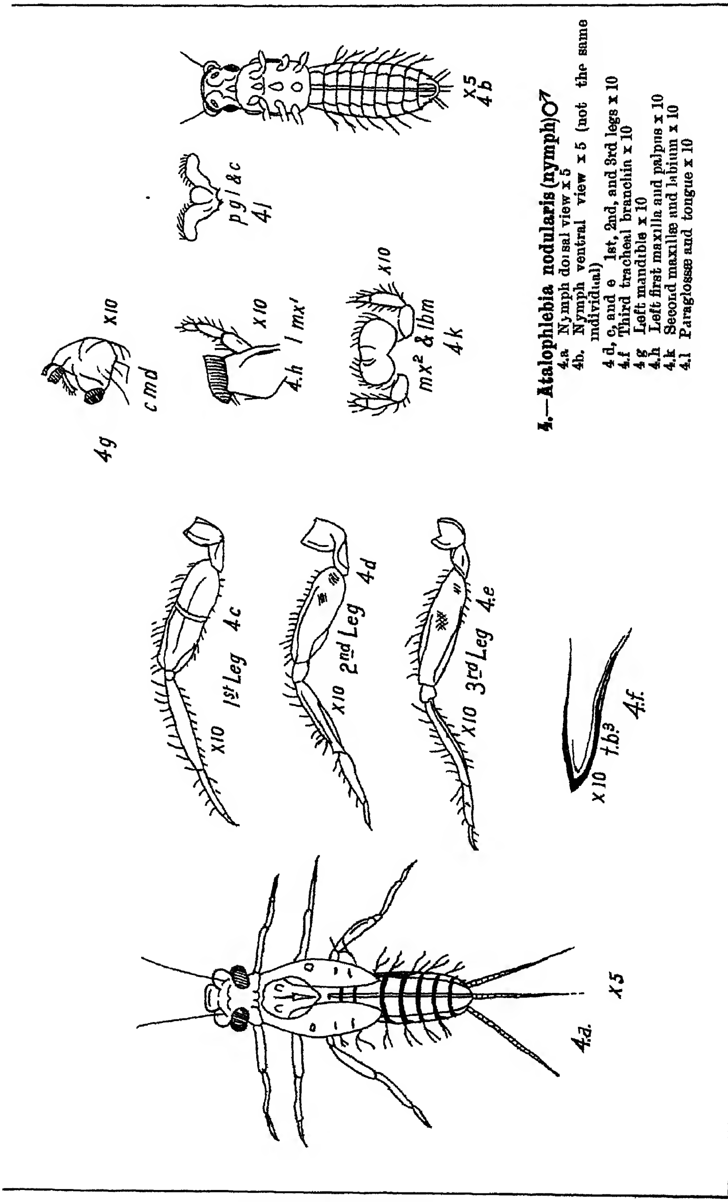


2.—Atalophlebia Scita Subimago ♀
2 a Head dorsal view x 10
2 b, c, d. 1st, 2nd, and 3rd legs x 10

EPHEMERIDÆ
(Lillie)



EPHEMERIDÆ.
(Lillie)

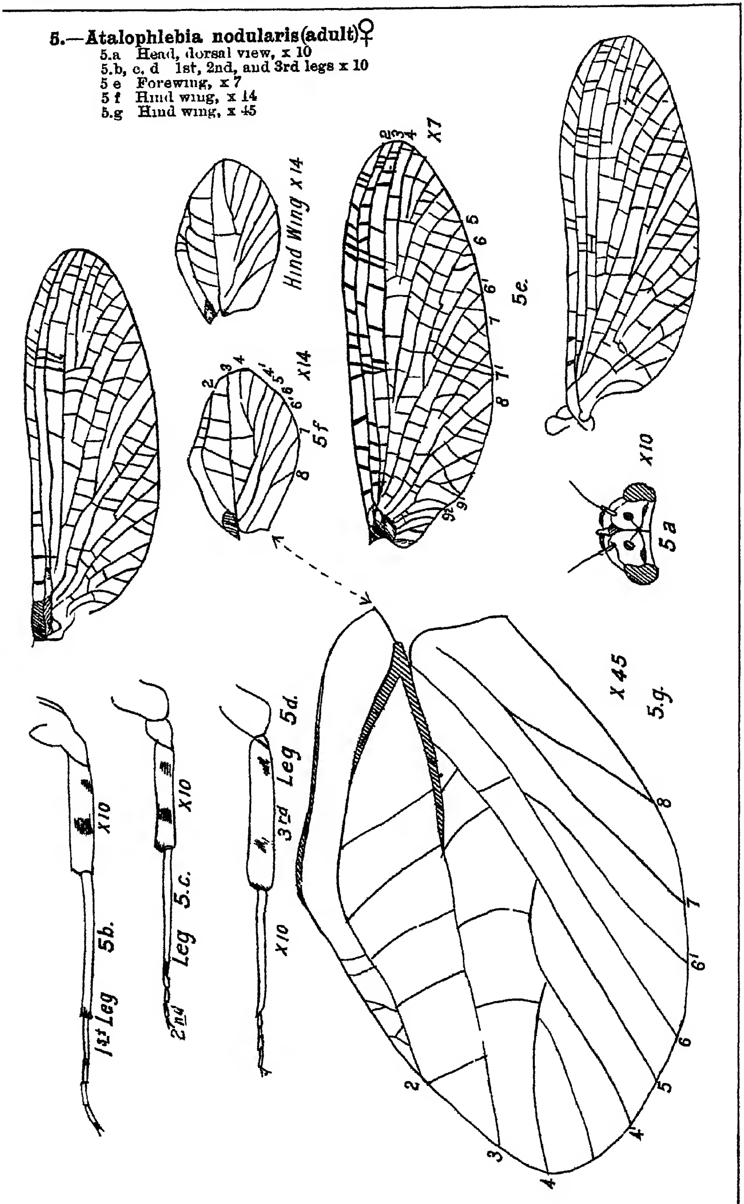


4.—Atalophlebia nodularis (nymph) ♂
4.a Nymph dorsal view x 5
4b. Nymph ventral view x 5 (not the same individual)
4 d, c, and e 1st, 2nd, and 3rd legs x 10
4.f Third tracheal branchia x 10
4 g Left mandible x 10
4.h Left first maxilla and palpus x 10
4.k Second maxillæ and labium x 10
4.l Paraglossæ and tongue x 10

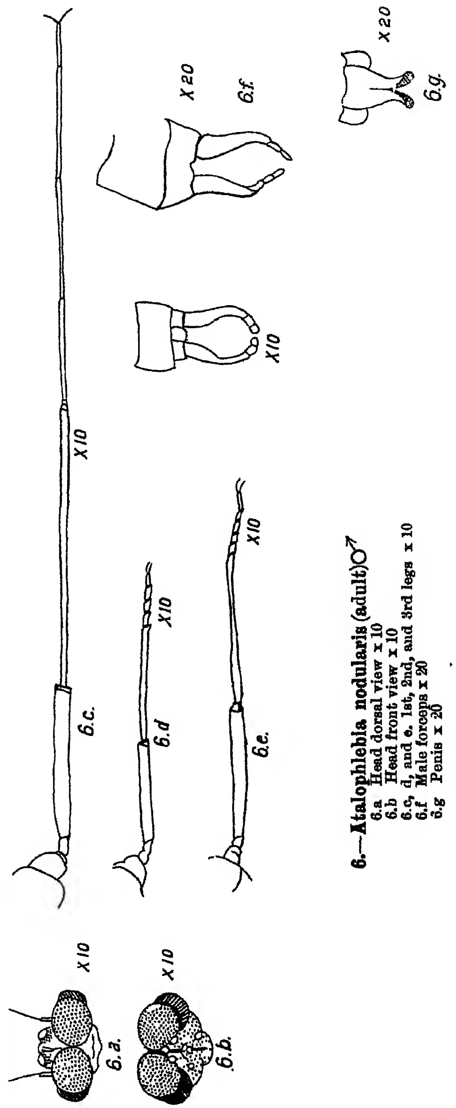
EPHEMERIDÆ.
(Lillie)

5.—Atalophlebia nodularis (adult) ♀

5.a Head, dorsal view, x 10
5.b, c, d 1st, 2nd, and 3rd legs x 10
5 e Forewing, x 7
5 f Hind wing, x 14
5.g Hind wing, x 45

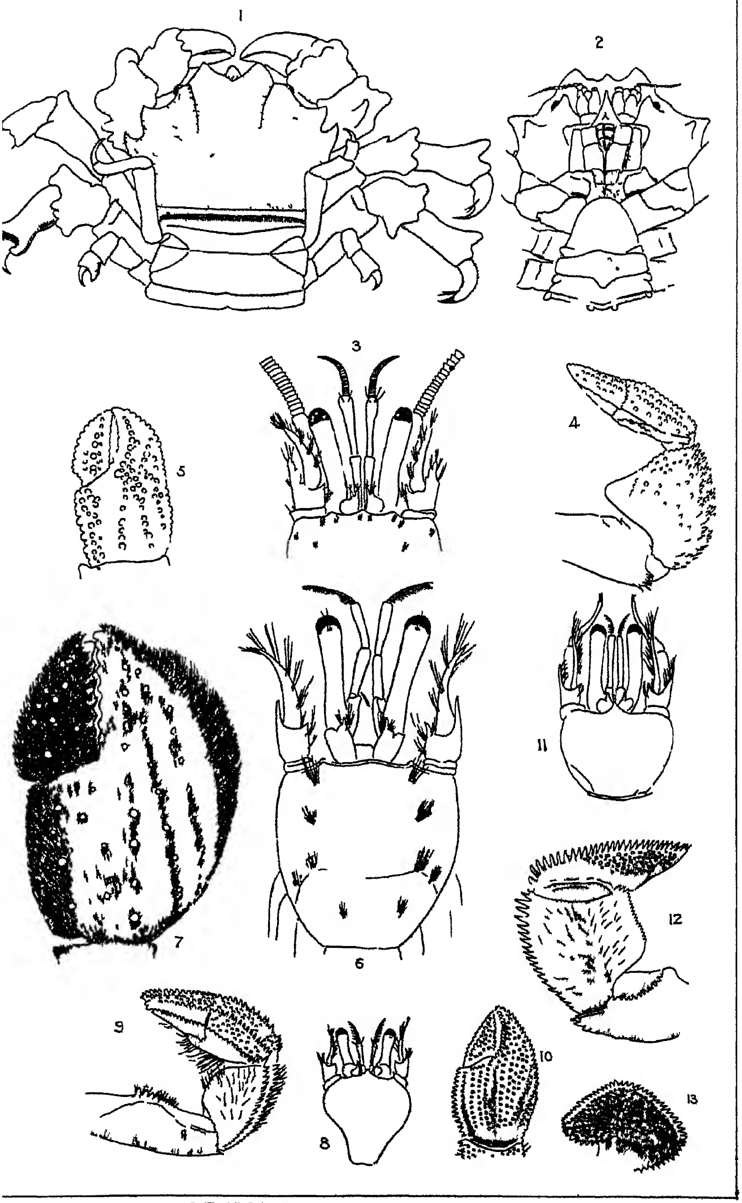


EPHEMERIDÆ.
(Lillie)



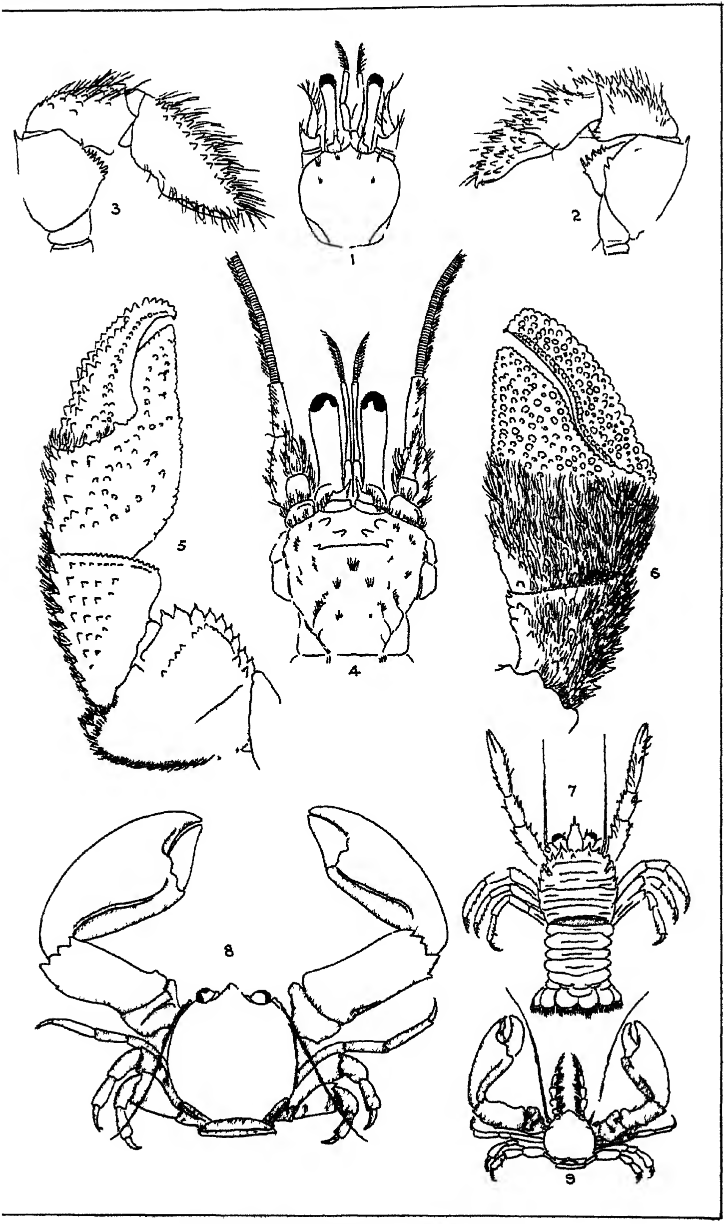
6.—Atalophlebia nodularis (adult) ♂
6.a Head dorsal view x 10
6.b Head front view x 10
6.c, d, and e. 1st, 2nd, and 3rd legs x 10
6.f Male forceps x 20
6.g Penis x 20

EPHEMERIDÆ.
(Lillie)

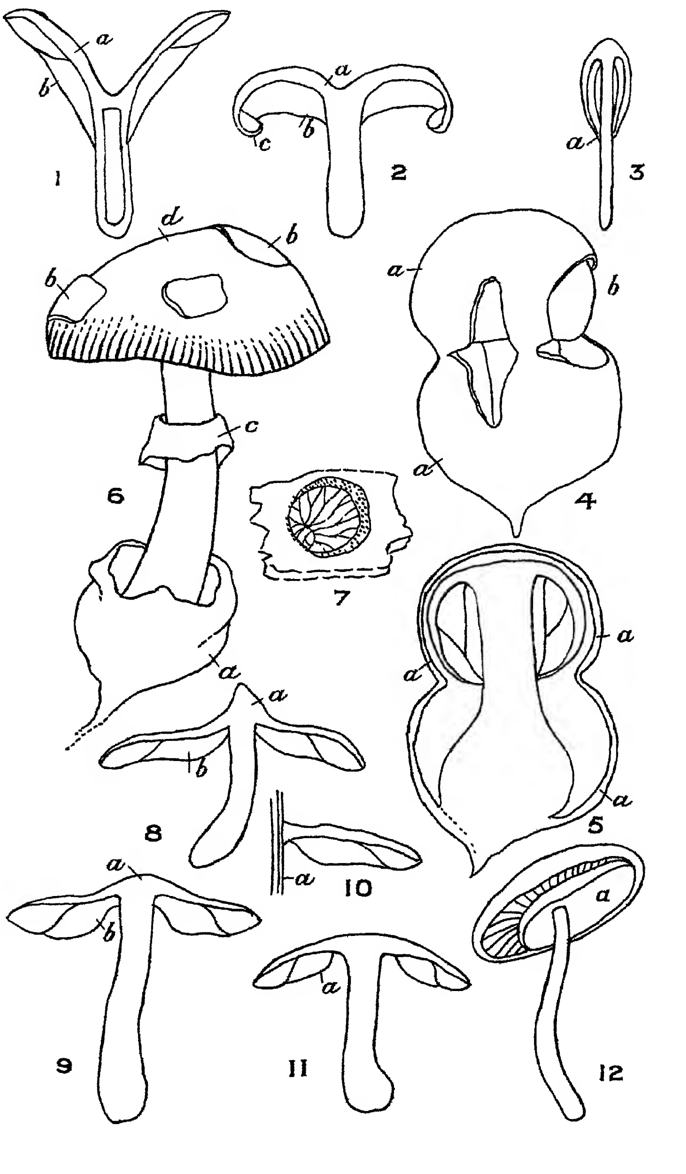


CRUSTACEA ANOMURA

(Thomson)

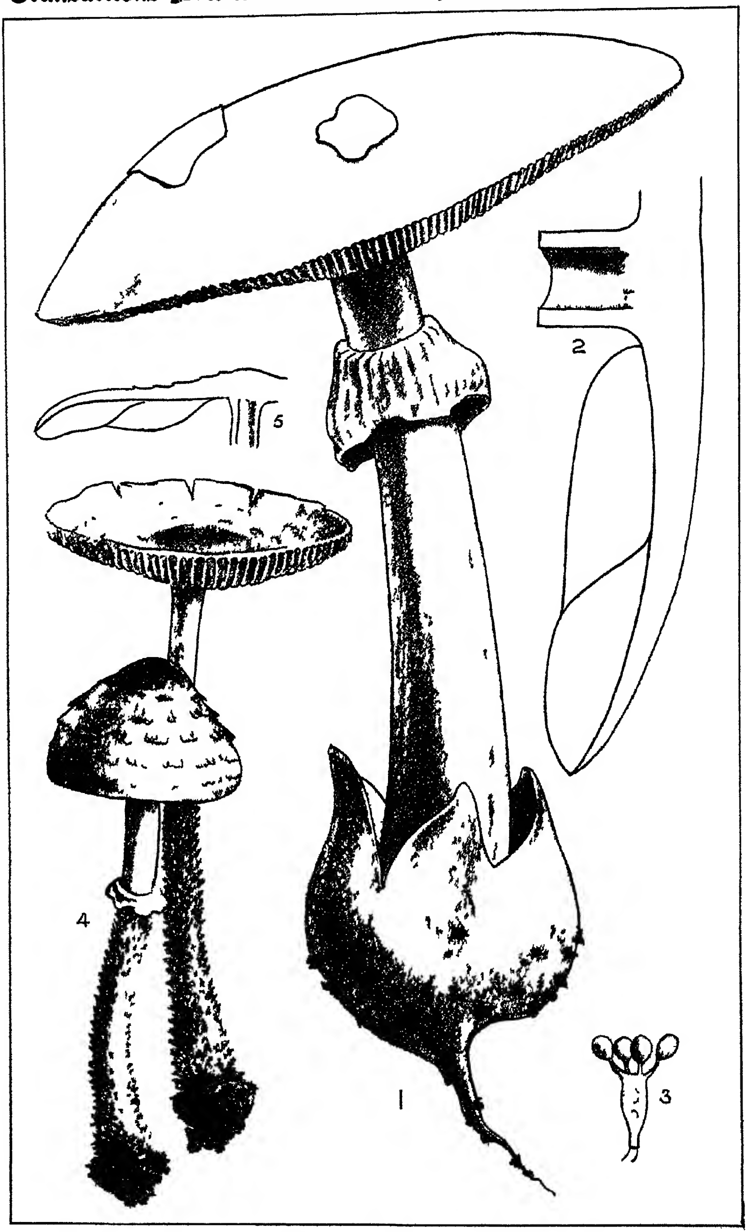


CRUSTACEA ANOMURA.
(Thomson)



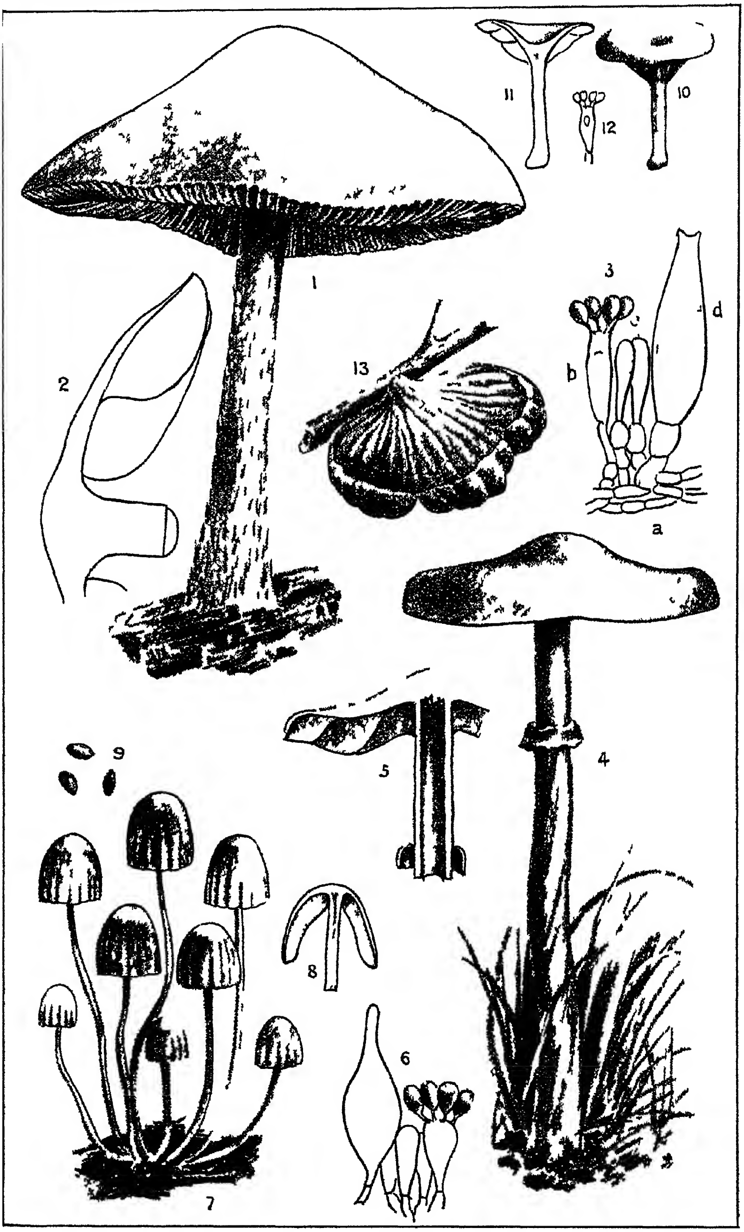
N.Z. FUNGI.

(Massee)

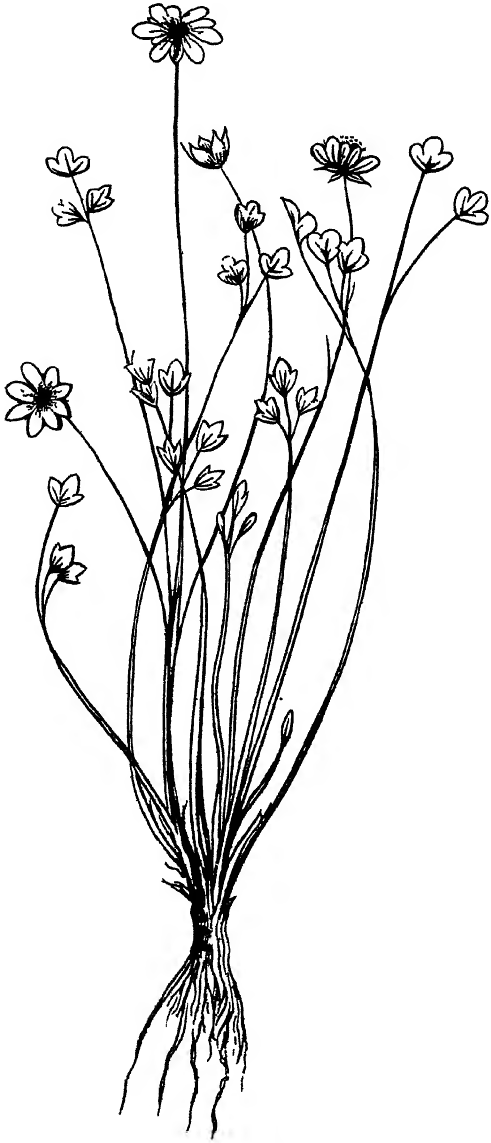


N.Z. FUNGI.

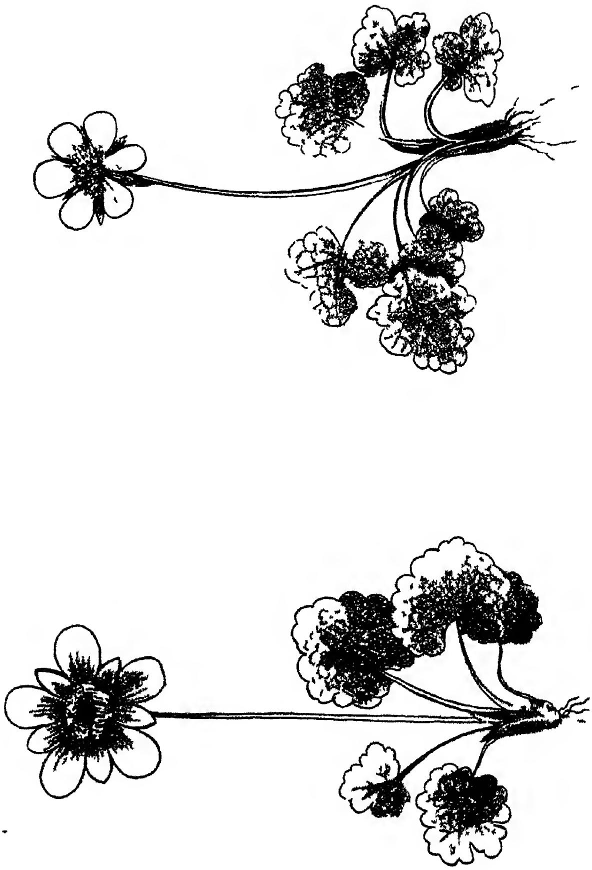
(Massee)



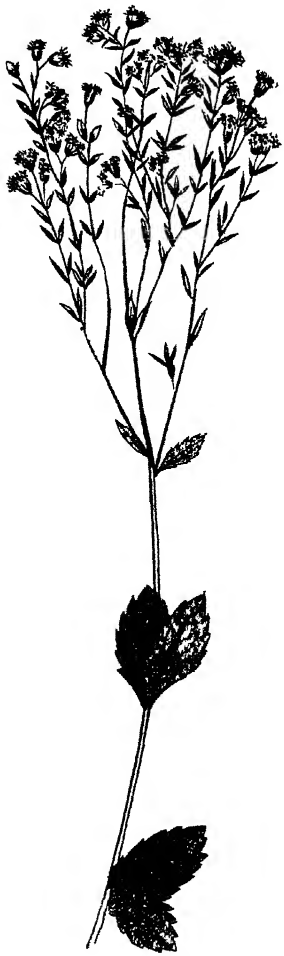
N.Z. FUNGI
(Massee)



RANUNCULUS KIRKII.
(Petrie)



RANUNCULUS BERGGRENI.
(Petrie)

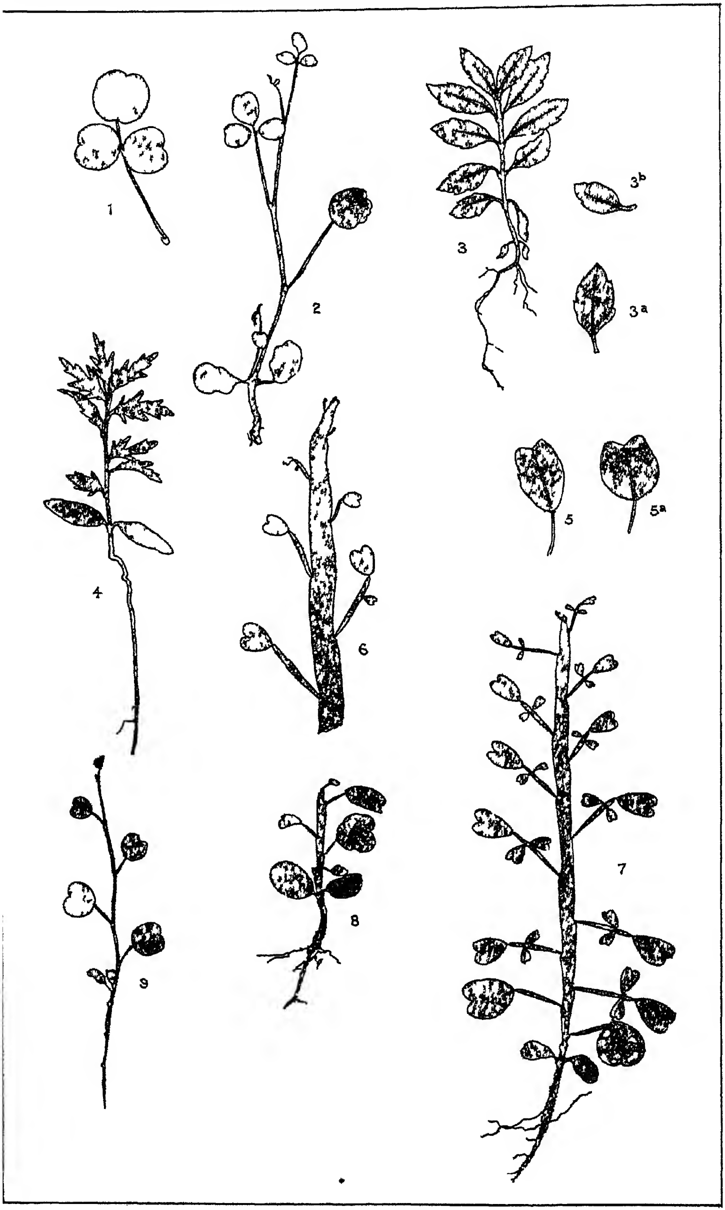


HALORAGIS SPICATA.
(Petrie)

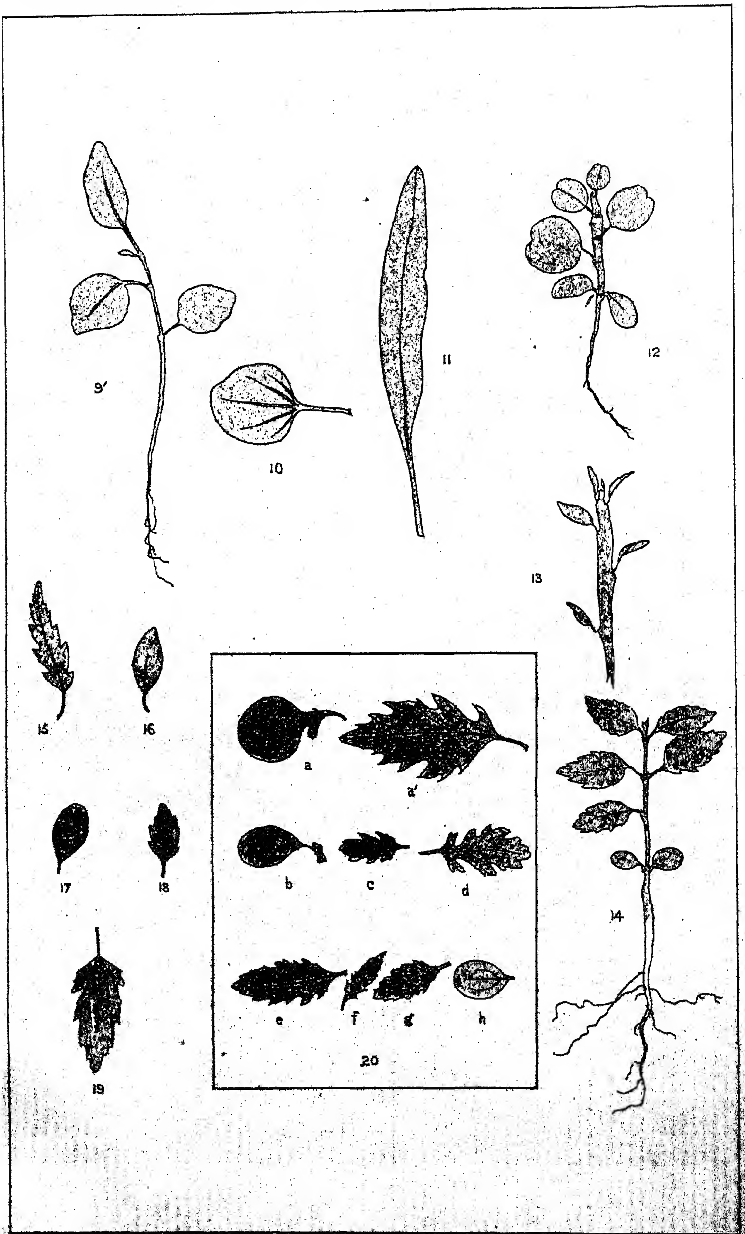
VERONICA ARMSTRONGII

Cockayne

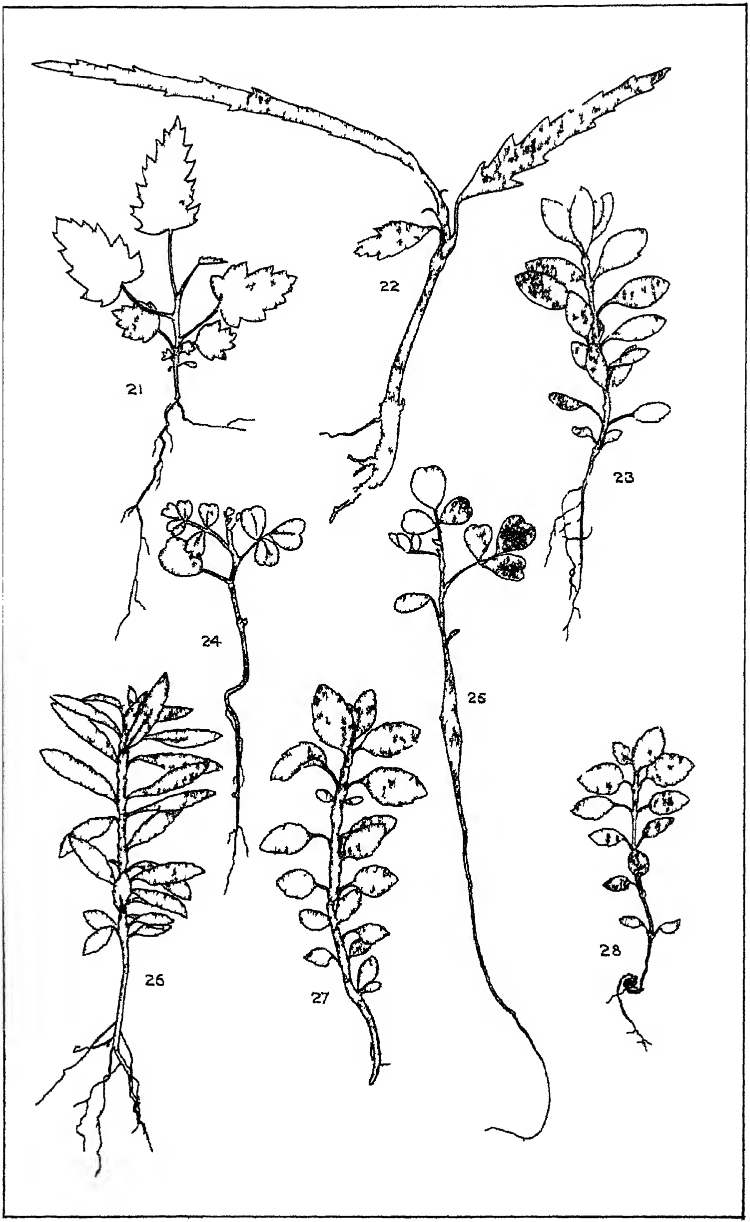
VERONICA ARMSTRONGII
Cockayne



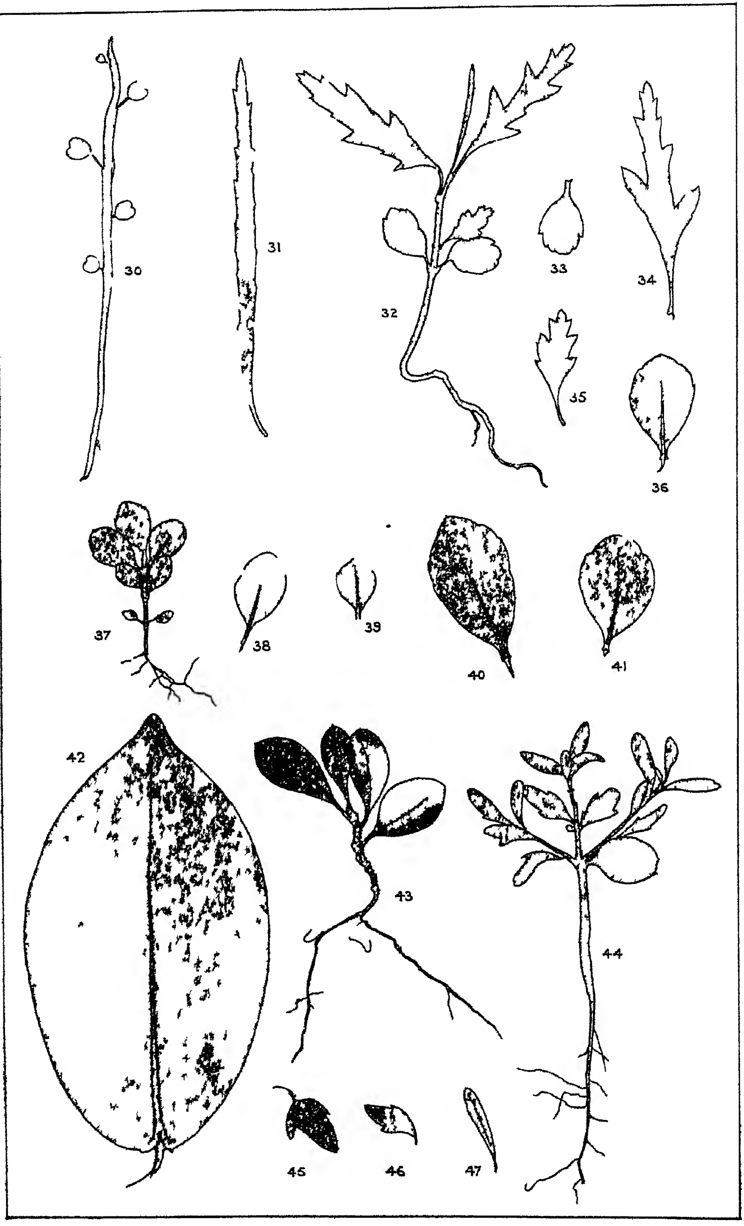
SEEDLINGS.
(Cockayne.)



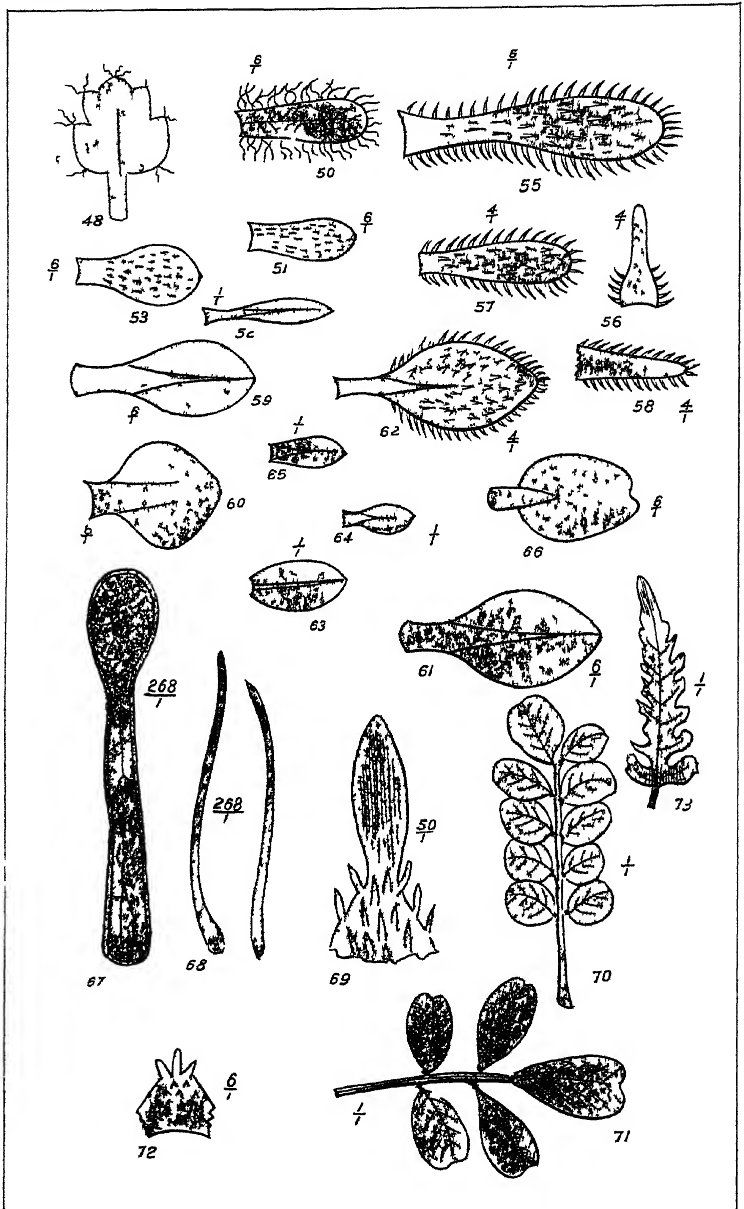
SEEDLINGS.
(Cockayne.)



SEEDLINGS.
(Cockayne)



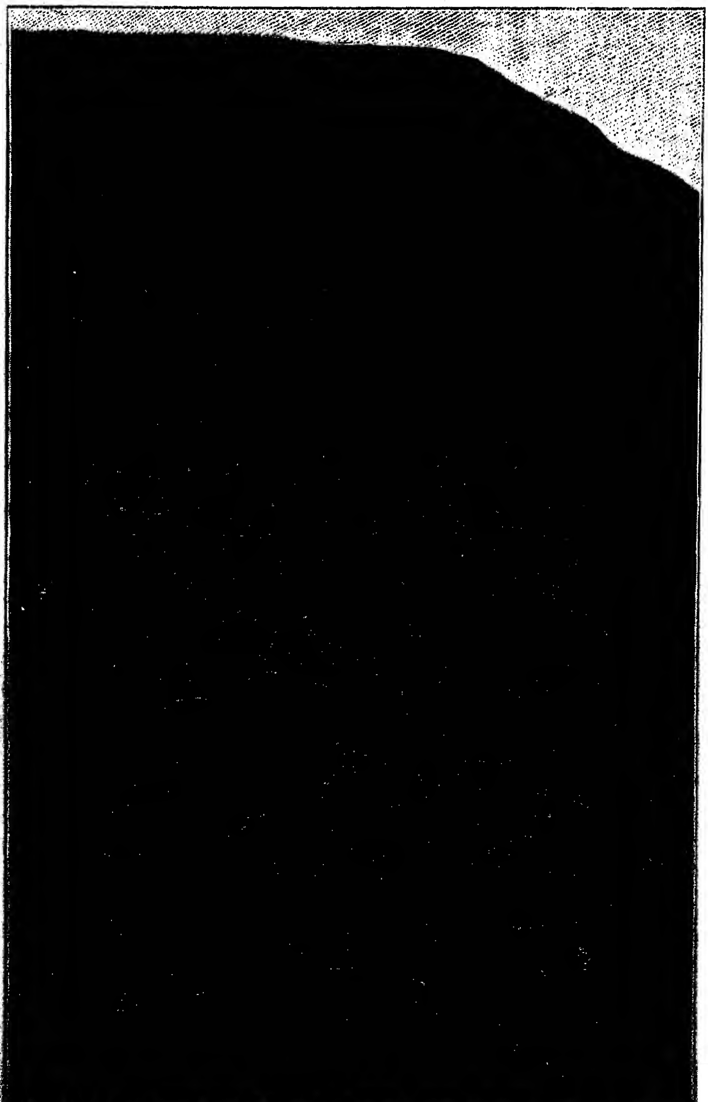
SEEDLINGS.
(Cockayne)



SEEDLINGS
(Cockayne)

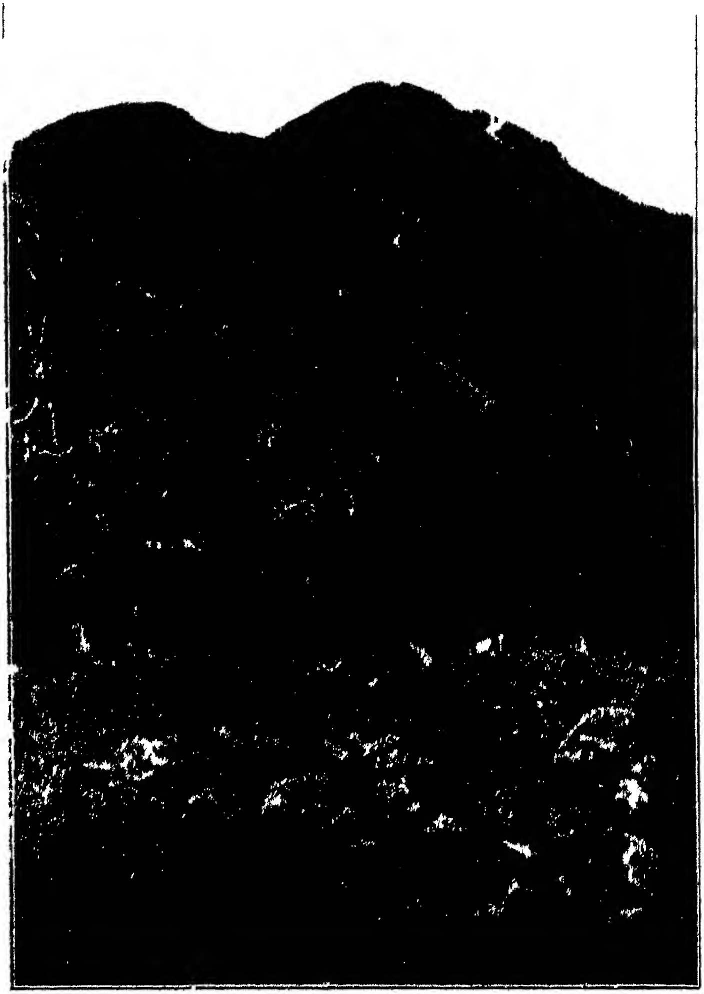
SUBALPINE SCRUB

Cockayne



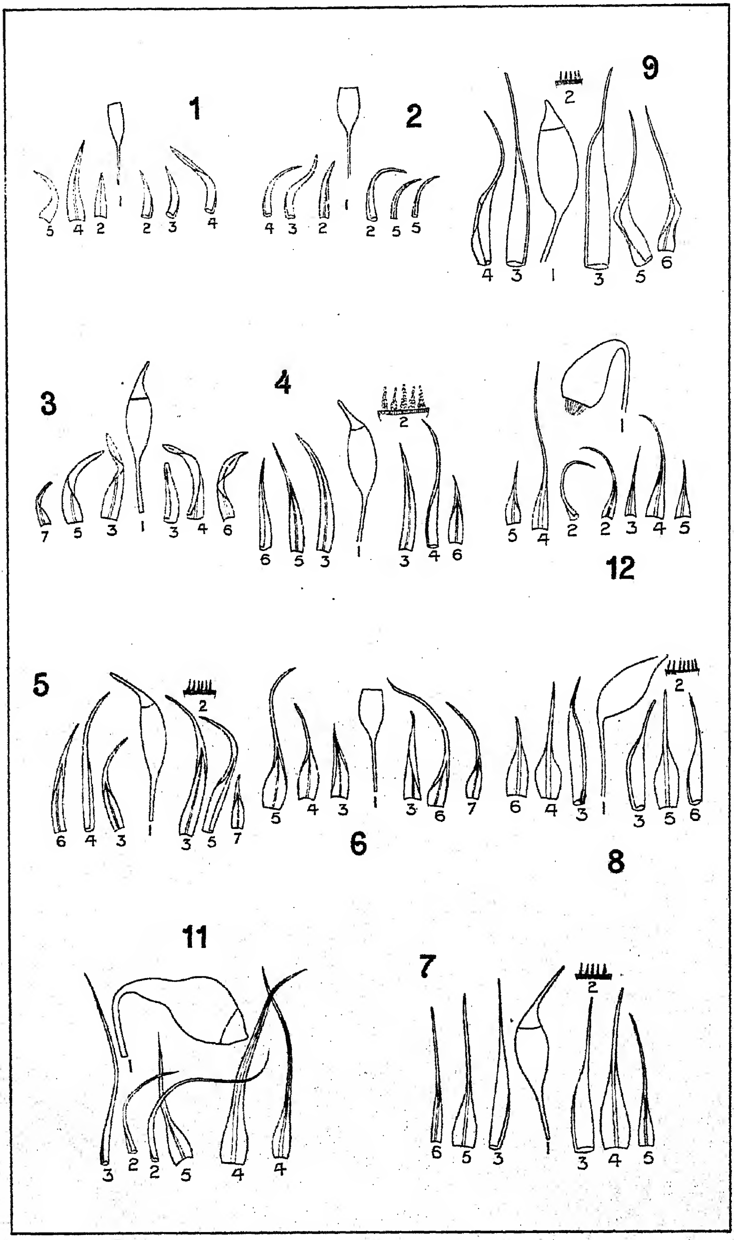
SUBALPINE PLANTS

Cockayne



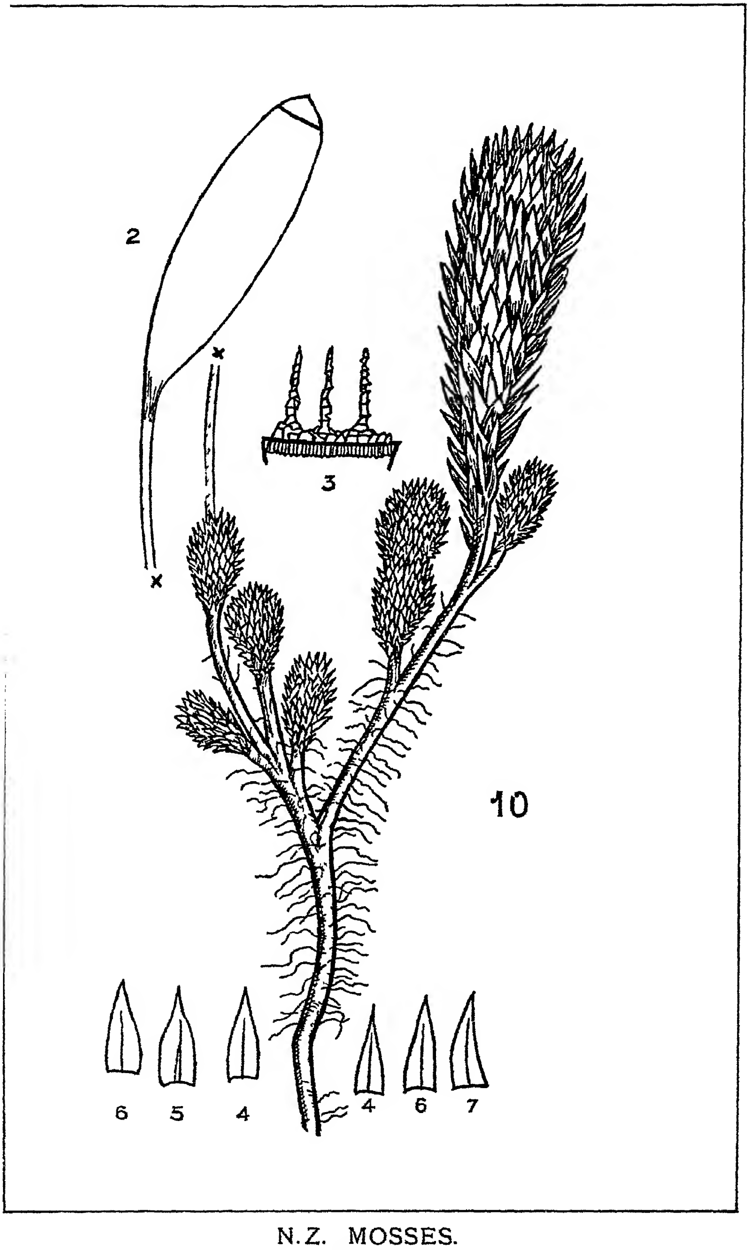
SUBALPINE SCRUB

Cockayne

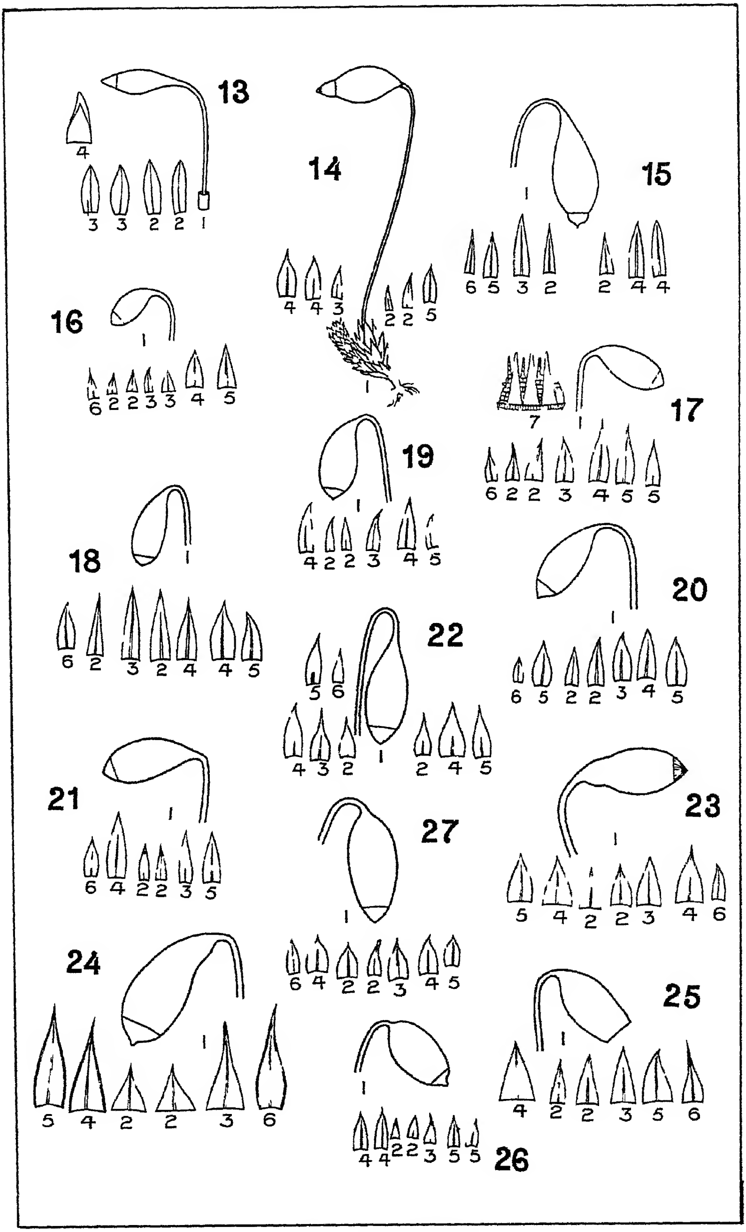


N.Z. MOSSES.

(Brown.)

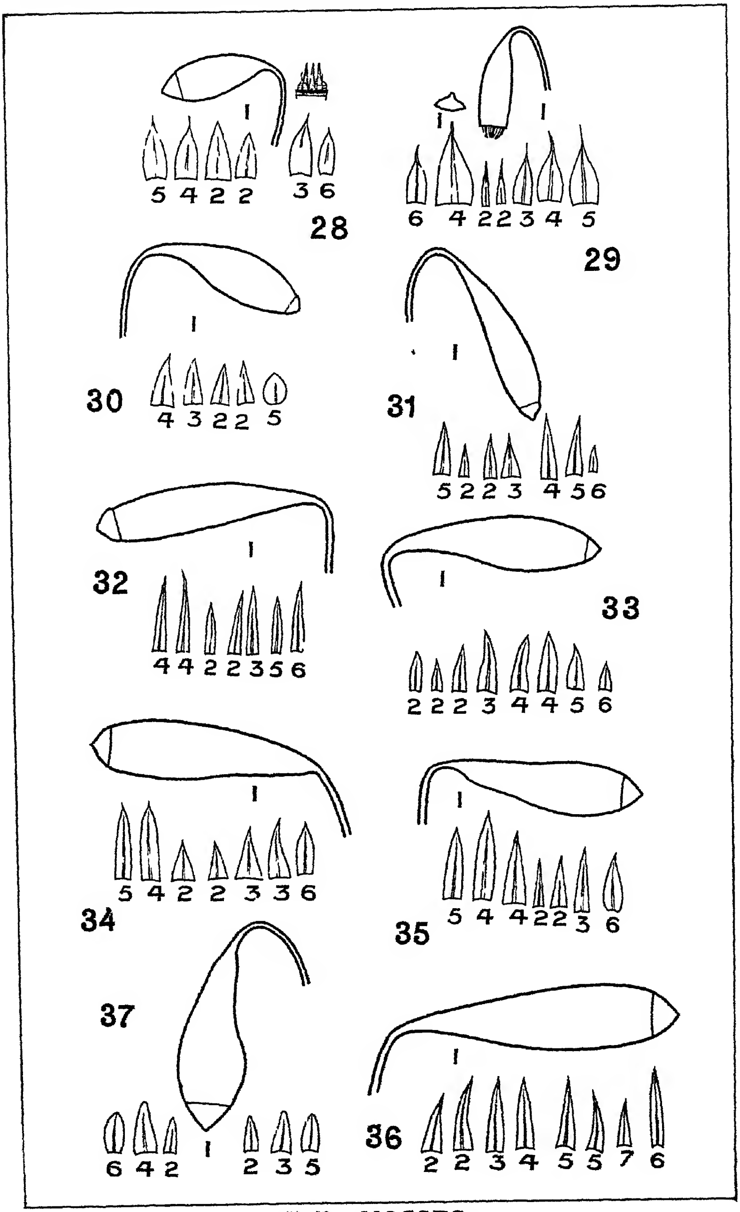


N.Z. MOSSES.
(Brown)



N Z. MOSSES

(Brown)



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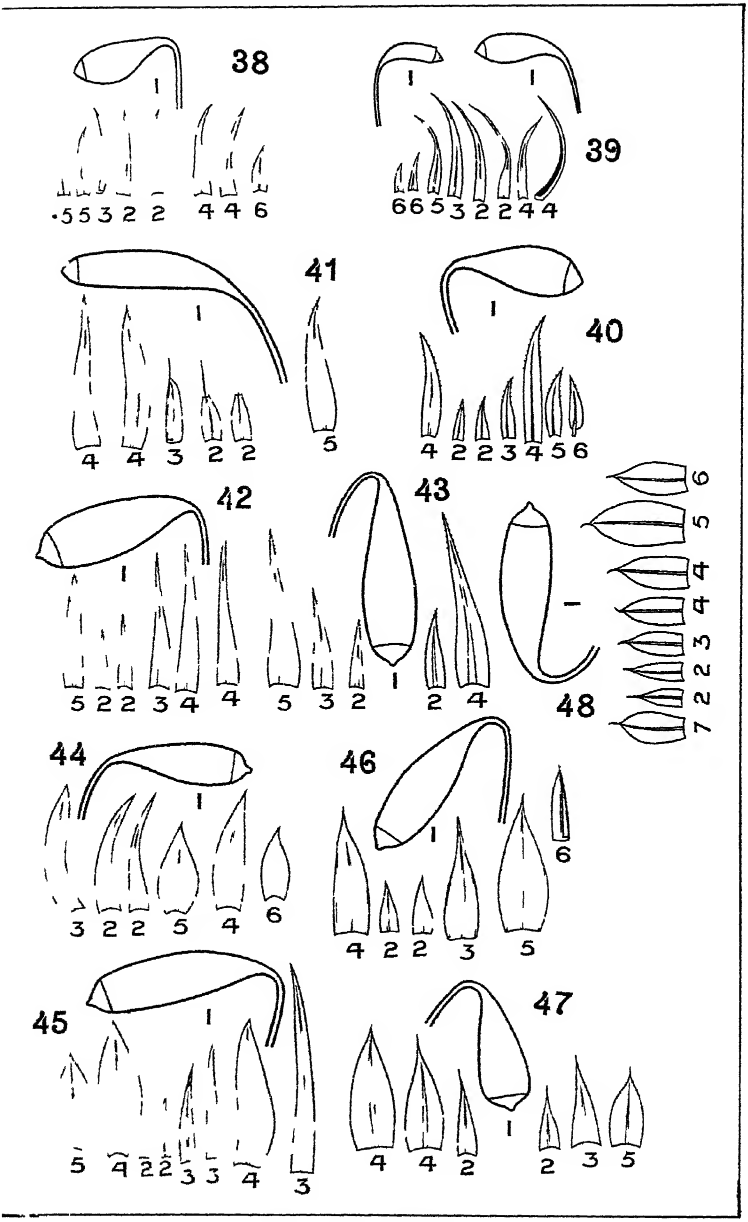
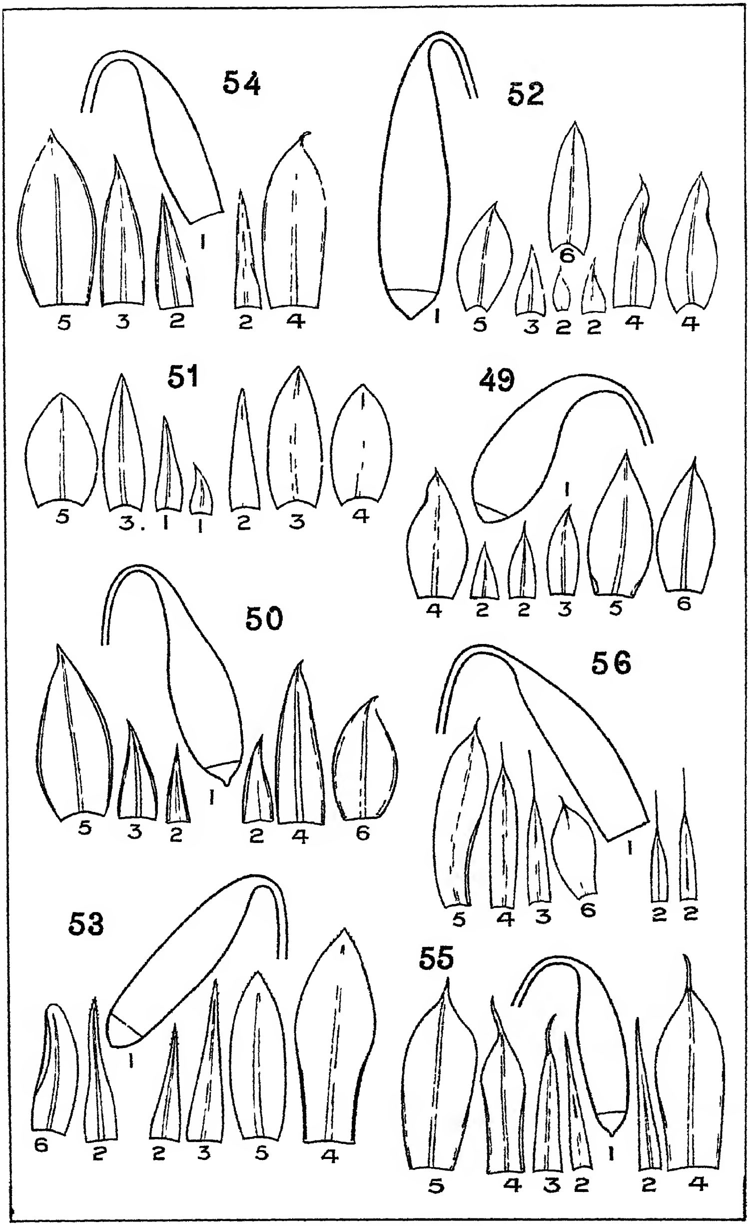
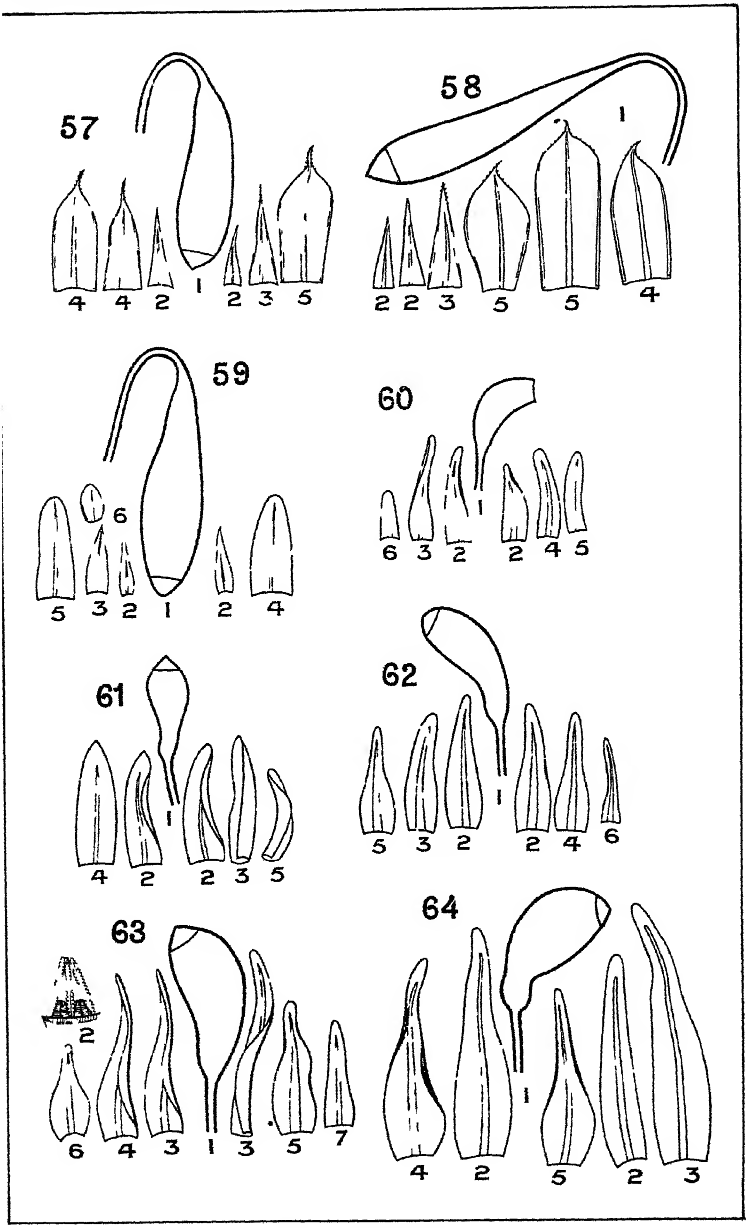


N Z MOSSES
(Brown)



N.Z. MOSSES.

(Brown.)



N Z. MOSSES

(Brown)

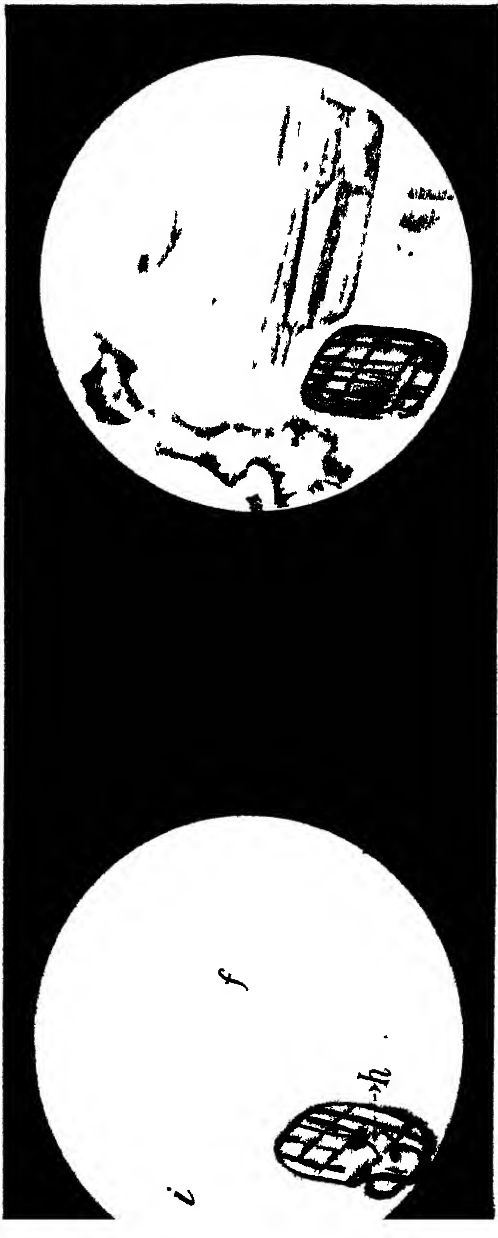
KIWI-LIKE FOOTPRINT
Hutton

2

1

2

1



2

1

CRYSTALLIZED GOLD

Maclaren

Fig 1

Crystal zed Gold

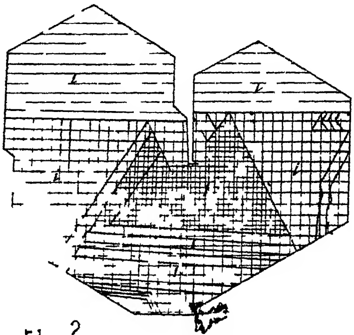


Fig 2

Leaf Gold
x 10

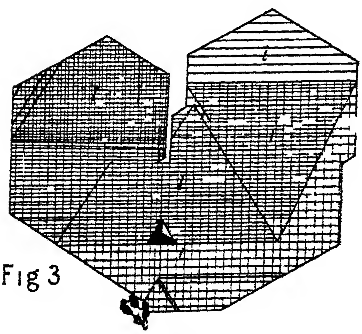


Fig 3

Leaf Gold
x 10

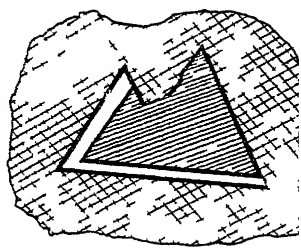


Fig 5

Octahedral Faces
x 10

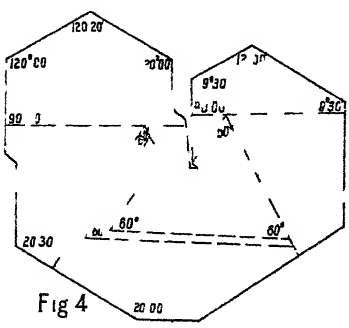
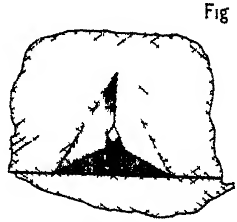
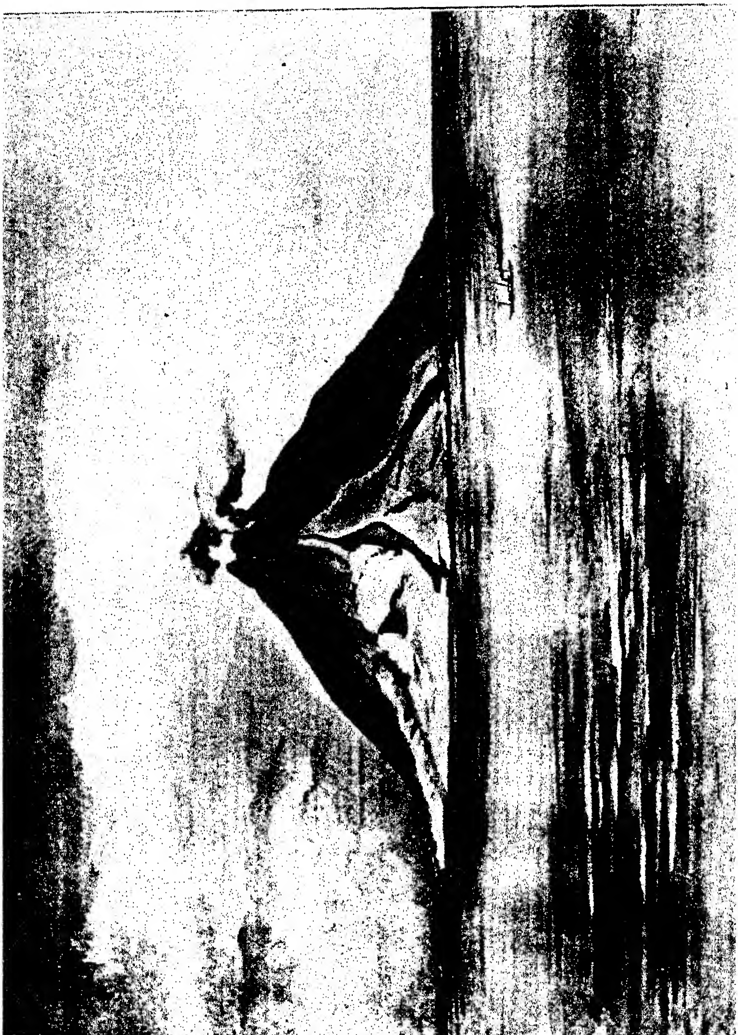


Fig 4

Fig 6



Cube Faces
x 40



VULCAN ISLAND, NEW GUINEA.

Phillips

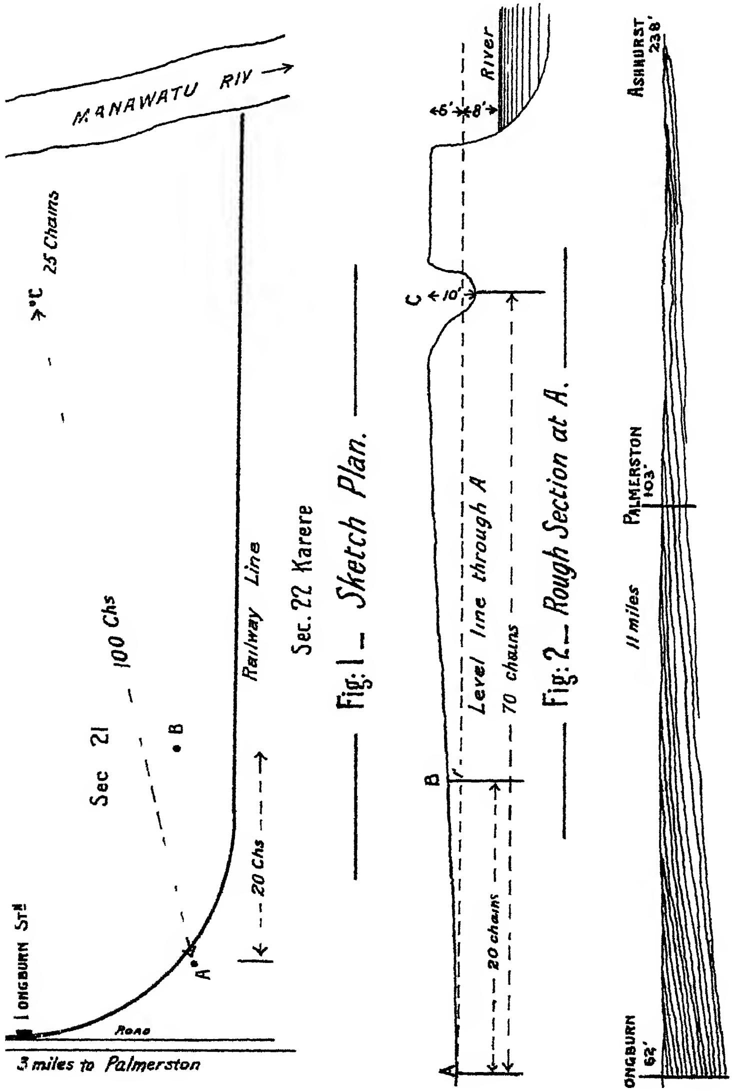
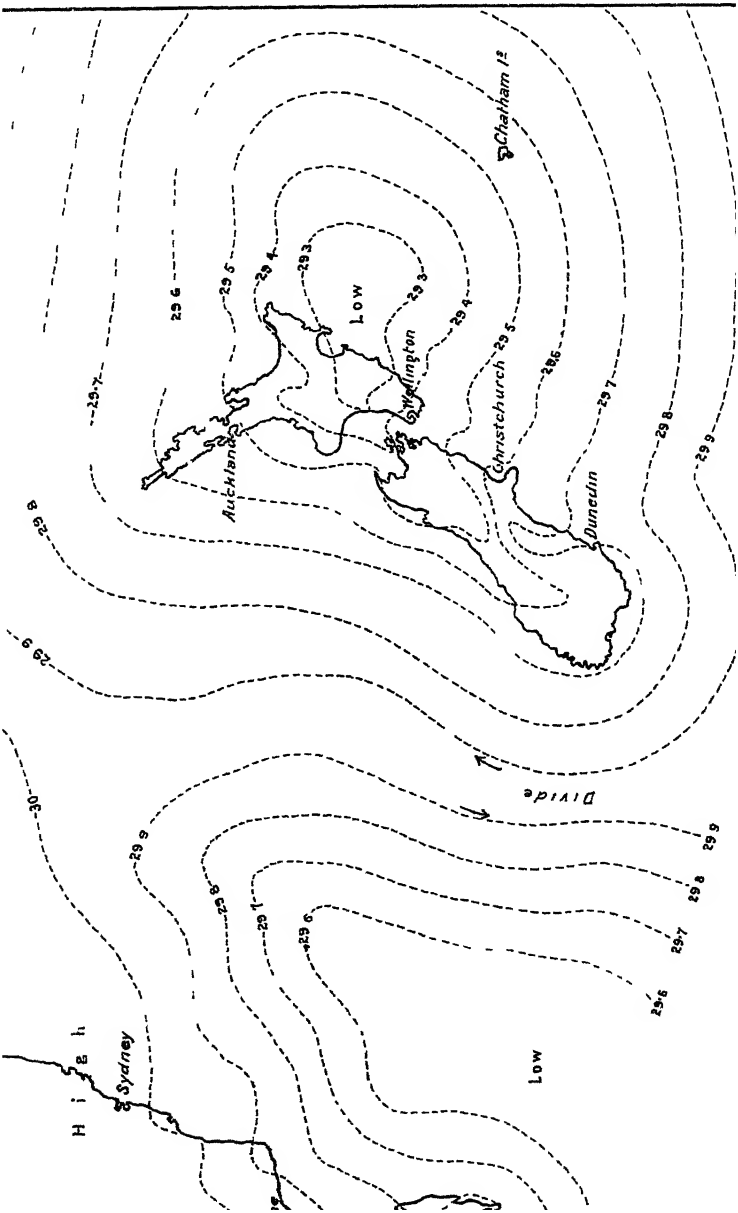
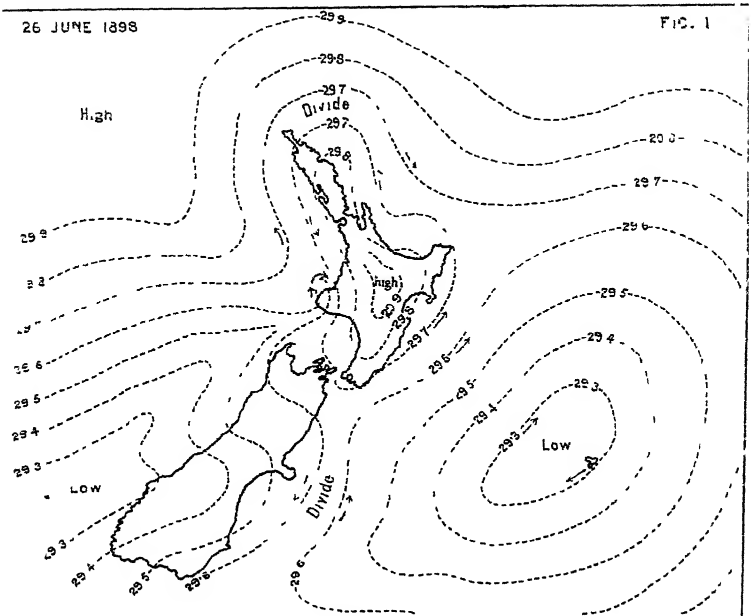


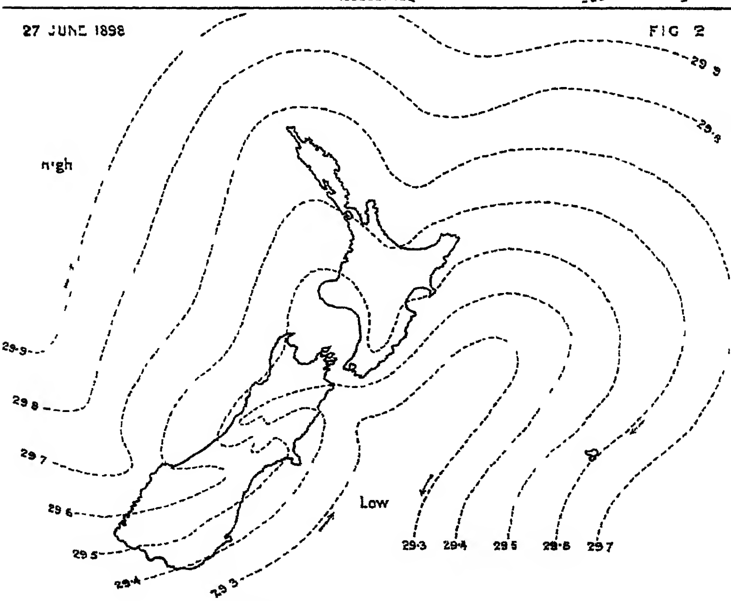
Fig: 1 — Sketch Plan.

Fig: 2 — Rough Section at A.



Chatham Is
Low
Wellington
Christchurch
Dunedin
Auckland
Sydney
High
Low
Divide
29.3
29.4
29.5
29.6
29.7
29.8
29.9
30





CYCLONIC CHART.
(Schaw.)

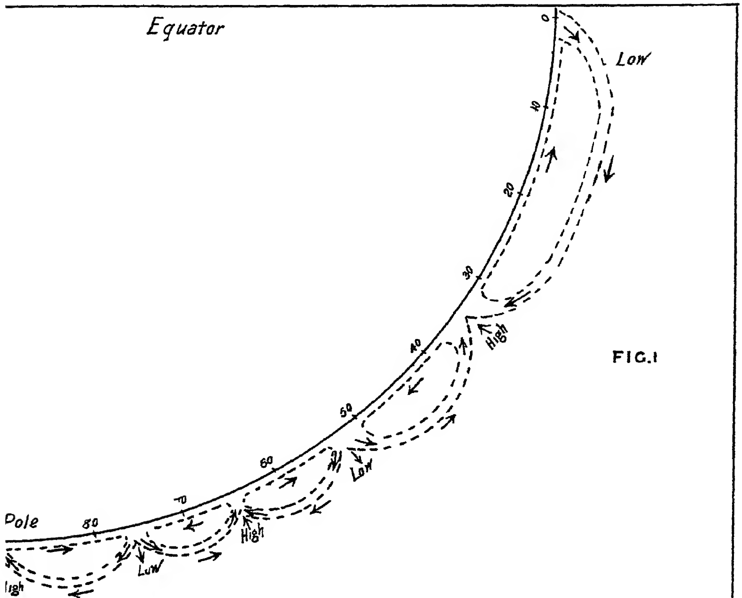


FIG. 1

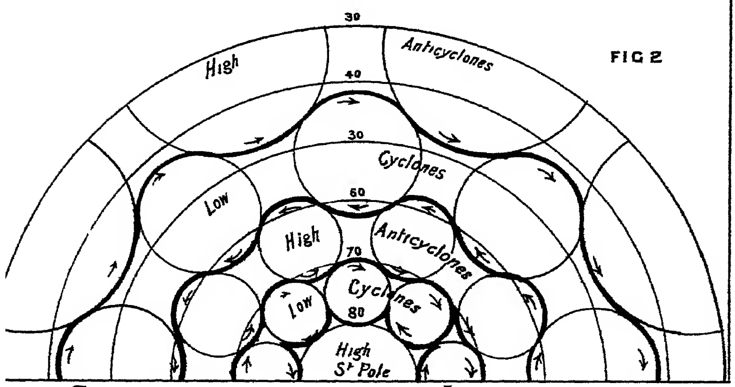
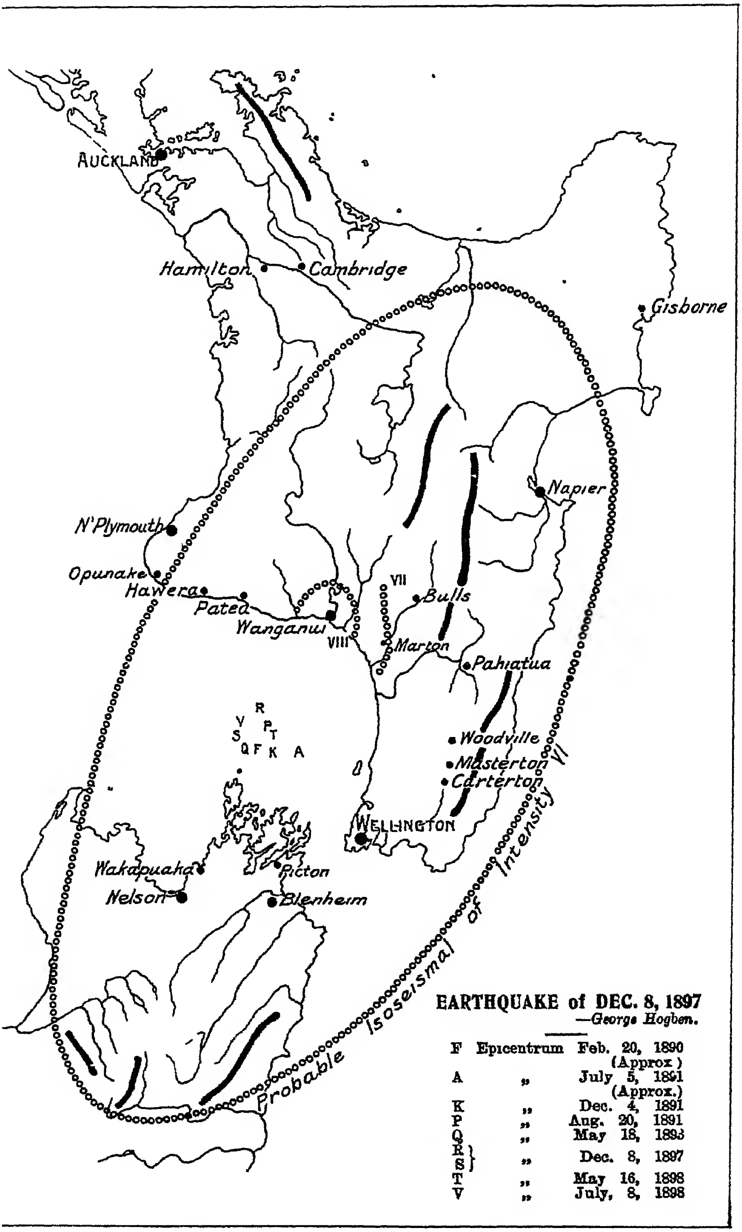


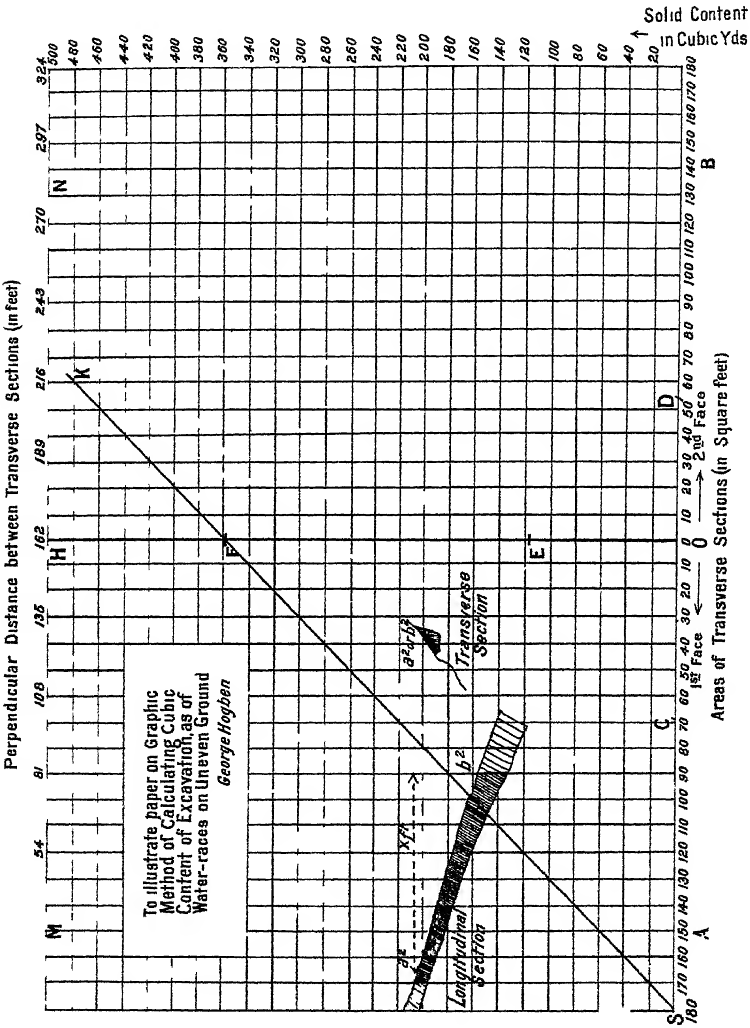
FIG 2

CIRCULATION OF THE ATMOSPHERE.

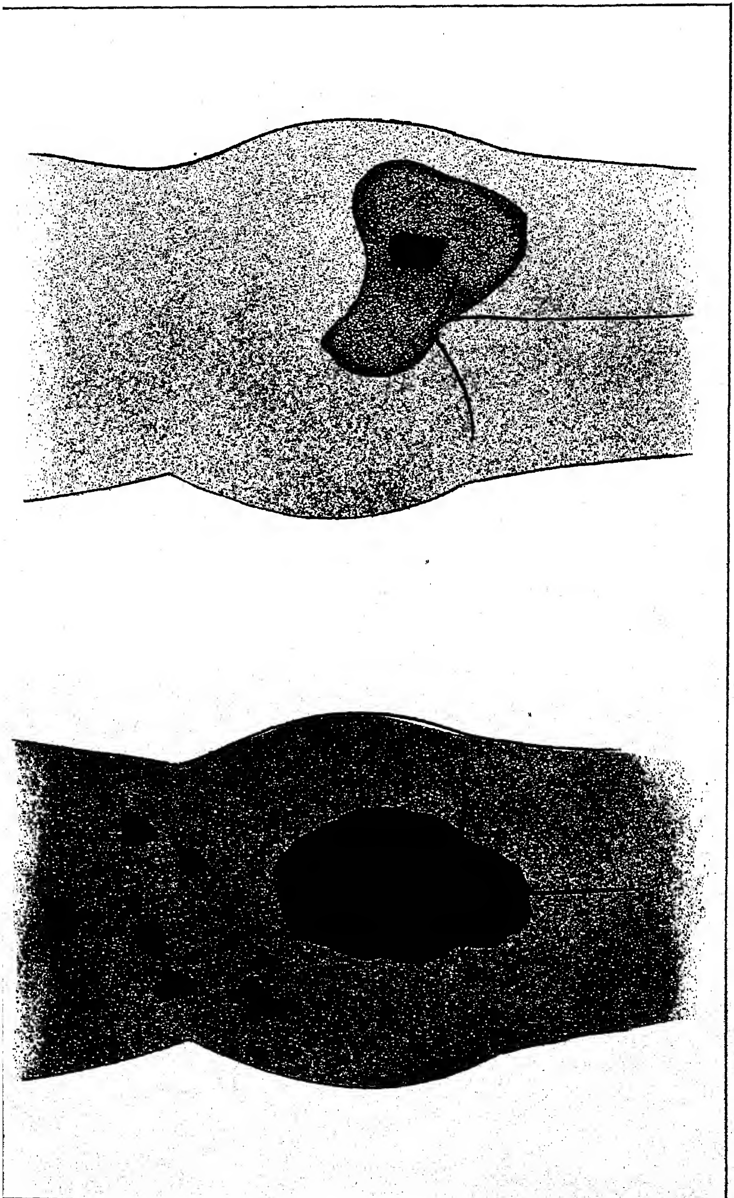
(Schaw)



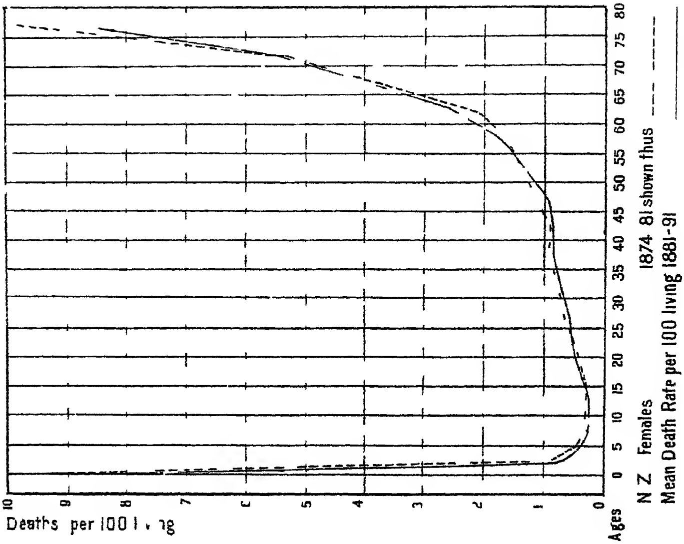
WANGANUI EARTHQUAKE.
(Hogben)

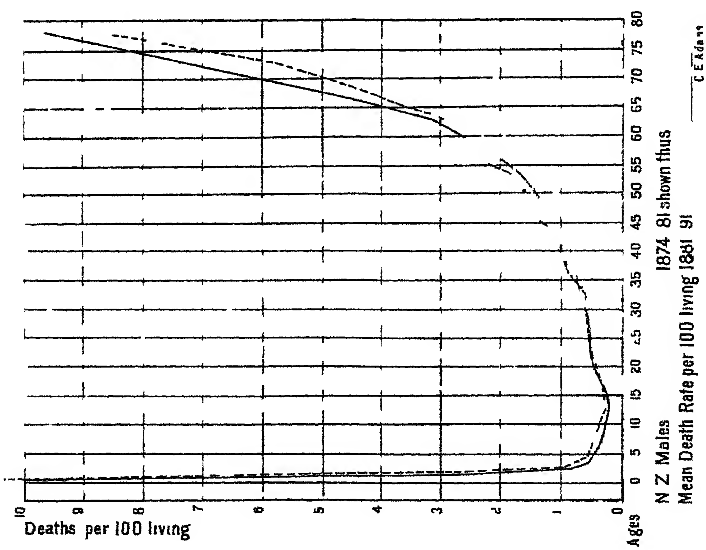


CALCULATING EXCAVATIONS
(Hogben)



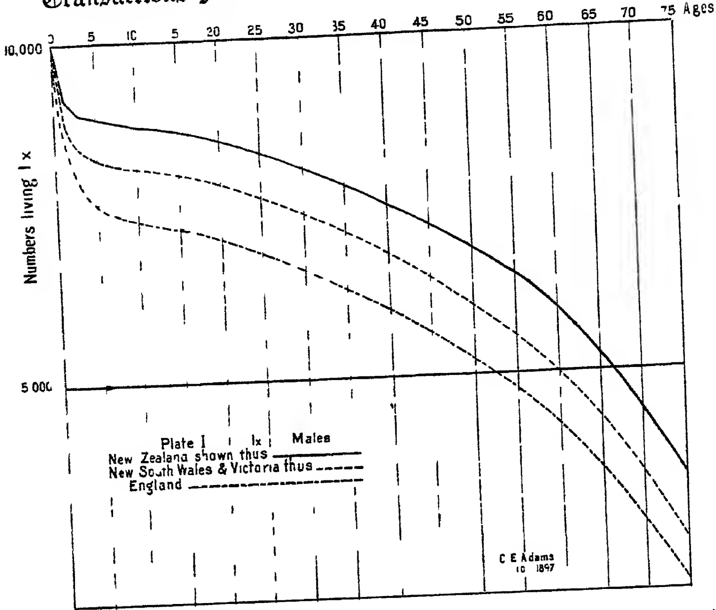
CONGENITAL STIGMATA.
(Tregear)

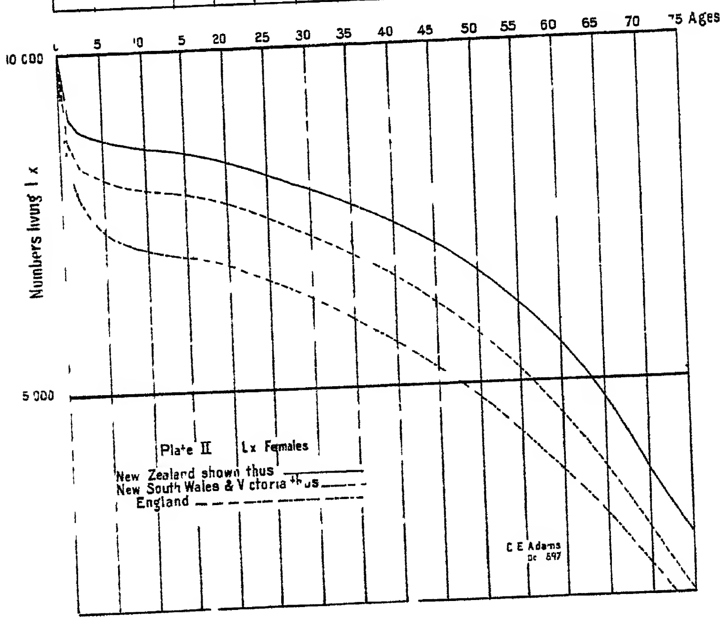




NEW ZEALAND MORTALITY

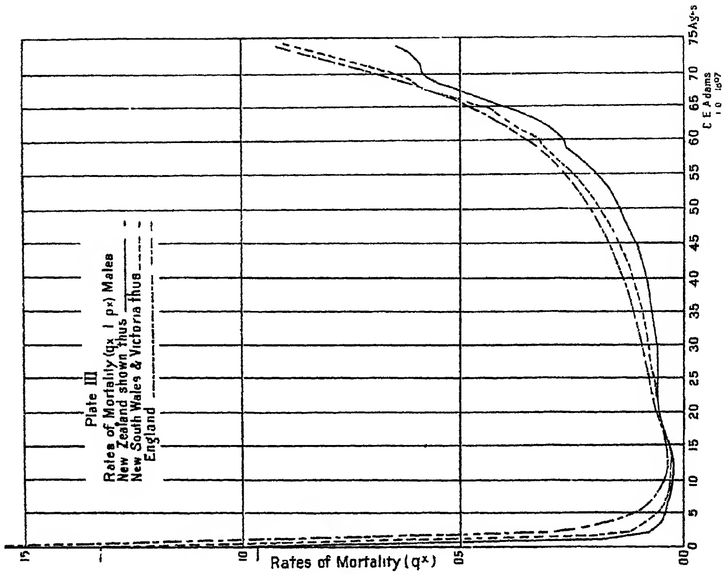
(Adams)

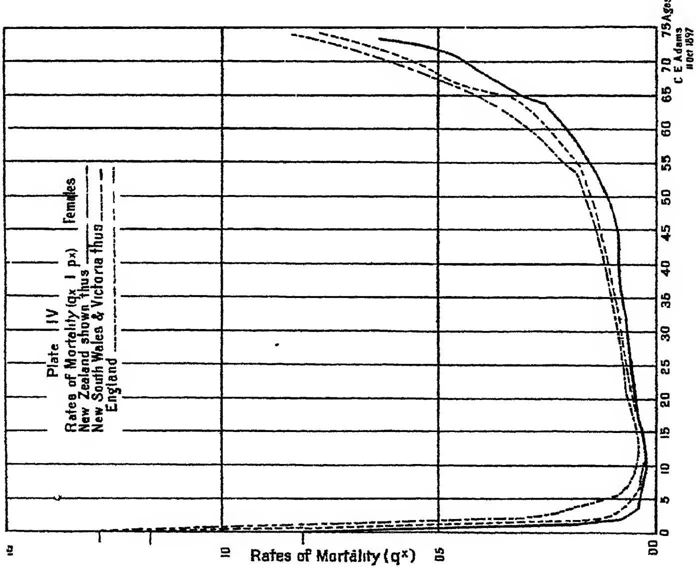




COMPARATIVE MORTALITY.

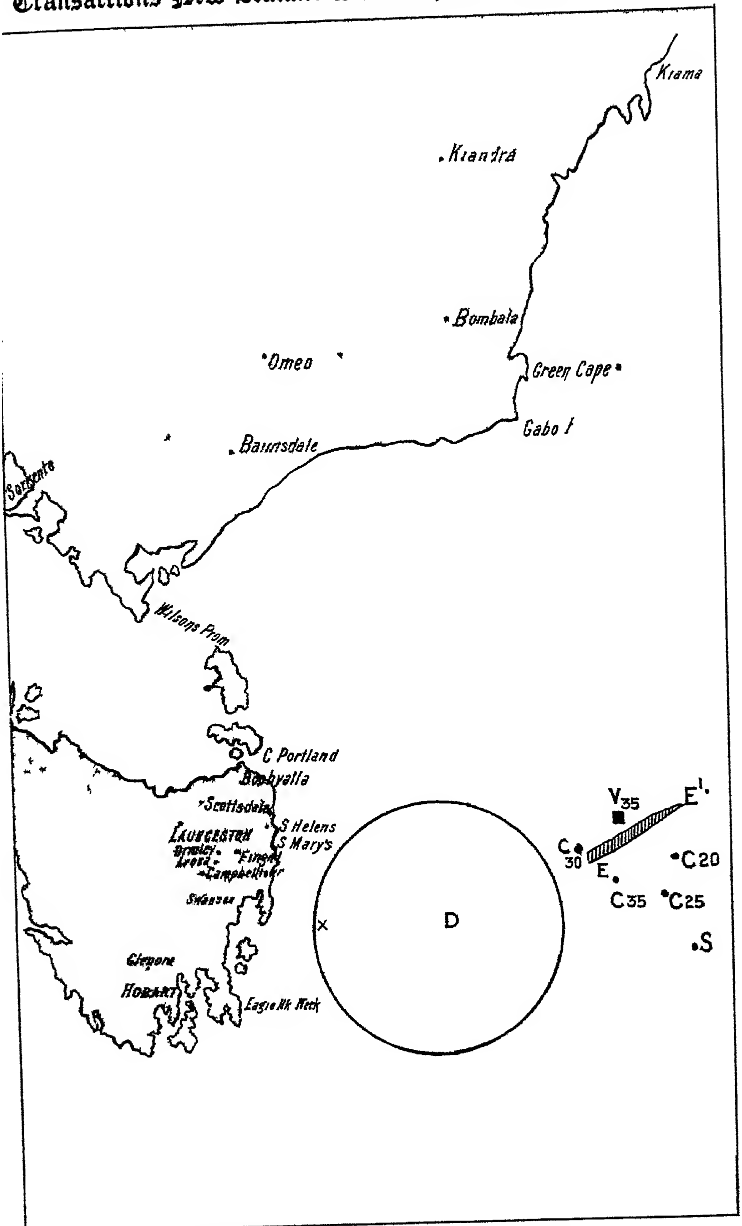
(Adams)





COMPARATIVE MORTALITY.

(Adams)



TASMANIAN EARTHQUAKES
(Hogben)

Yours very truly W Colenso